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TRANSACTIONS

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AMERICAN ENTOMOLOGICAL SOCIETY

VOLUME LXXXIV

# NEW RECORDS OF AQUATIC HETEROPTERA FROM THE UNITED STATES AND CANADA

BY SELWYN S. ROBACK

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The following new distributional records for aquatic Heteroptera were obtained during river surveys conducted by the Department of Limnology of the Academy of Natural Sciences of Philadelphia from 1950 to 1956. The specimens are preserved in alcohol and are in the Academy's insect collections. In all, 60 species from 35 rivers or streams and 1 lake are represented here. The distribution of these bodies of water is shown in the accompanying map.

The author is indebted to Mr. John C. Lutz for the determination of the species listed in this paper.

## Localities

Canada

1. St. Lawrence River near Maitland, Ontario; July 25-Aug. 11, 1952; Coll. S. S. Roback.
2. Cataraqui Bay, Lake Ontario near Kingston, Ontario; July 13-31, 1953; Coll. S. S. Roback.

New York

3. Sconondoa Creek near Vernon Center and Sherrill, New York; July 7-16, 1952; Coll. S. S. Roback.

PENNSYLVANIA

4. Clarion River near Cookesburg, Pa., Jefferson Co., Sept. 1951; Coll. T. Dolan, IV.
5. East Branch of Clarion River near Instanter, Pa.; Sept. 1951; Coll. T. Dolan, IV.
6. Tionesta Creek 5 miles below Kelletville, Pa.; Sept. 1951; Coll. T. Dolan, IV.
7. Rock Creek near Gettysburg, Pa.; July 26, 27, 1956; Coll. S. S. Roback.
8. Brandywine River-East branch where Rt. 322 crosses stream; Dec. 10, 1952, Sept. 10, 1956; Coll. S. S. Roback.
9. Brandywine River—West branch; Near Wawaset, Pa. Sept. 13, 1956; Coll. S. S. Roback.

10A. Schuylkill River at Leesport, Pa.; Sept. 29, 1953; Coll. T. Dolan, IV.

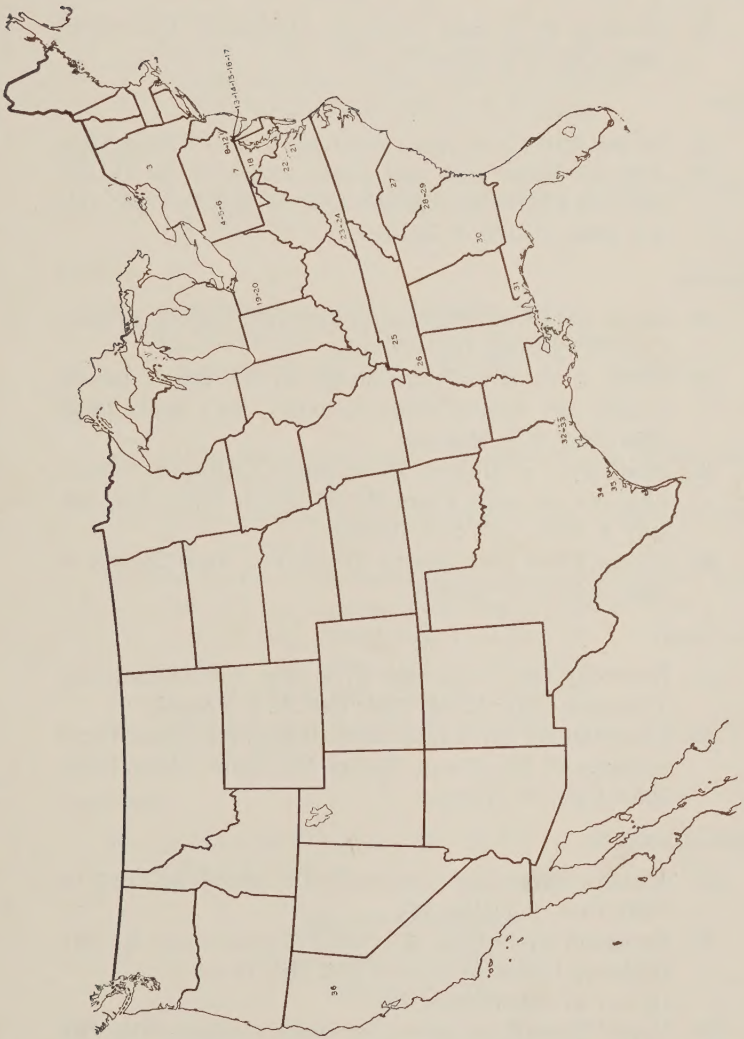
10B. Schuylkill River at Gibraltar, Pa.; Sept. 29, 1953; Coll. T. Dolan, IV; and Sept. 5, 1956; Coll. S. S. Roback.

10C. Schuylkill River above entrance of Wissahickon Creek, Philadelphia, Pa.; Sept. 12, 1956; Coll. S. S. Roback.

11. Branch of Buck Run near Parkesburg, Pa.; Sept. 11, 1956; Coll. S. S. Roback.
12. Lititz Run just above junction with Conestoga River; November 9, 1954; Coll. T. Dolan, IV and S. S. Roback.

PENNSYLVANIA-DELAWARE

13. Red Clay Creek from near Yorklyn, Pa. to near Stanton, Delaware; July 19-24, 1956; Coll. S. S. Roback.
14. White Clay Creek from near Landenberg, Pa. to near Stanton, Delaware; July 17-19, 1956 and Sept. 10, 1956; Coll. S. S. Roback.
15. Tributary of West Branch Creek near Newark, Delaware; May 1951; Coll. T. Dolan, IV.
16. West branch Creek above junction with Persimmon Run; May 1951; Coll. T. Dolan, IV.
17. Christina Creek, southwest of Newark, Delaware; May 1951; Coll. T. Dolan, IV.



Map showing numbered collection localities.

MARYLAND

18. Patomac River near Frederick Maryland; June 13-18, 1956; Coll. S. S. Roback.

OHIO

19. Ottawa River from just above Lima to near Kalida, Ohio.
20. Auglaize River from just above mouth of the Ottawa River to Cloverdale bridge; June 30-July 8, 1955; July 2-6, 1956; Coll. S. S. Roback.

VIRGINIA

21. James River near Richmond, Va.; July 23-Aug. 6, 1951; Coll. W. Nutting and J. Lattin.
22. North Anna River from bridge on Rt. 208 to mouth, Louisa and Spottsylvania Counties, Va.; Sept. 25-30, 1954; Coll. S. S. Roback.
23. North Fork of Holston River from 12 miles above Saltville, Va. to point where Rt. 23 crosses river; June 28-July 4, 1954; Coll. S. S. Roback.
24. Clinch River near Speer's Ferry, Va.; June 28-July 4, 1954; Coll. S. S. Roback.

TENNESSEE

25. Kentucky Lake, Tennessee River near New Johnsonville, Tennessee; July 12-25, 1955; Coll. S. S. Roback.
26. Loosahatchie River from below Brunswick, Tenn. to the entrance of Big Creek, Shelby Co. Tenn.; June 13-24, 1951; Coll. W. Nutting.

SOUTH CAROLINA

27. Wateree River near Camden, S. C.; March 29-April 11, 1950; Coll. T. Dolan, IV.
28. Savannah River from Mile 134-175; just above Rt. 301, Highway bridge to below Clark Hill Dam.
    (a to f as below under 29.)
29. Upper Three Runs, enters Savannah at about Mile 170;
    a. June 25-July 14, 1951; Coll. T. Dolan, IV.
    b. Oct. 15-Nov. 31, 1951; Coll. T. Dolan, IV & S. S. Roback.

c. May 5-May 22, 1952; Coll. T. Dolan, IV & S. S. Roback.
d. Aug. 17-31, 1954; Coll. S. S. Roback.
e. Aug. 24-Sept. 7, 1955; Coll. S. S. Roback.
f. May 10-17, 1956; Coll. S. S. Roback.

GEORGIA

30. Flint River near Albany Ga.; Sept. 15-Oct. 5, 1952; Coll. T. Dolan, IV.

FLORIDA

31. Escambia River near Pensacola, Fla.;
    a. Oct 22-Nov. 7, 1952; Coll. S. S. Roback.
    b. March 23-April 10, 1953; Coll. S. S. Roback.

TEXAS

32. Neches River near Beaumont, Texas; Aug. 10-24, 1953; Coll. T. Dolan, IV.
33. Sabine River near Orange, Texas; Aug. 12-Sept. 2, 1952; Coll. T. Dolan, IV.
34. Guadalupe River from Seguin, Texas to just above junction with San Antonio River below Victoria, Texas;
    a. Sept. 1-15, 1949; Coll. T. Dolan, IV.
    b. Sept. 1-15, 1950; Coll. T. Dolan, IV.
    c. Aug. 17-31, 1952; Coll. T. Dolan, IV.
35. Mission Lake, Texas near Seadrift, Texas; May 1954; Coll. C. Wurtz.

CALIFORNIA

36. Sacramento River near Red Bluff, Cal.; Aug. 8-13, 1956; Coll. S. S. Roback.

## Family **CORIXIDAE**

### Subfamily CORIXINAE

### Tribe CORIXINI

*Palmacorixa buenoi* Abbott

1913. Can. Ent., XLV: 113-116.

Canada (1); Pennsylvania-Delaware (17); South Carolina (28f); Texas (34c).

*Palmacorixa nana* Walley

1930. Can. Ent., LXII: 106.

Ohio (19); Virginia (23).

*Corisella decolor* (Uhler)

1871. Amer. Jl. Sci., Ser. 3, I: 106.

California (36).

*Trichocorixa borealis* Sailer

1948. Kans. U. Sci. Bull., XXXII: 308-310.

Ohio (19).

*Trichocorixa calva* (Say)

1832. Say's Entomology, Le Comte, VI: 366 (*Corixa*).

Canada (1); New York (3); Pennsylvania (7, 9, 10AC, 12); Maryland (18); Ohio (19, 20); Virginia (24); Tennessee (25); South Carolina (28abcdf); Texas (33).

*Trichocorixa kanza* Sailer

1948. Kans. U. Sci. Bull., XXXII: 318-321.

Pennsylvania-Delaware (13); Maryland (18); South Carolina (28e); Florida (31); Texas (34c).

*Trichocorixa verticalis verticalis* (Fieber)

1851. Acta. Reg. Bohem. Soc. Scient., p. 24.

Canada (1).

*Hesperocorixa lucida* (Abbott)

1916. Ent. News, XXVII: 341.

South Carolina (29c).

*Cenocorixa wileyi* (Hungerford)

1926. Can. Ent., LVIII: 271-272.

California (36).

*Sigara* (*Vermicorixa*) *alternata* (Say)

1825. Jl. Acad. Nat. Sci. Phila., IV: 329.

Pennsylvania (12); Ohio (19).

*Sigara* (*Vermicorixa*) *modesta* (Abbott)

1916. Ent. News, XXVII: 343.

Canada (2); New York (3); Pennsylvania (7, 8, 9, 11, 12); Pennsylvania-Delaware (13, 14); Ohio (19, 20).

*Sigara* (*Vermicorixa*) *virginiensis* Hungerford

1948. Kans. U. Sci. Bull., XXXII: 671-673.

Virginia (22).

*Sigara* (*Vermicorixa*) *grossolineata* Hungerford
1948. Kans. U. Sci. Bull., XXXII: 676-681.
Ohio (19); California (36).

*Sigara* (*Phaeosigara*) *compressoidea* (Hungerford)
1928. Can. Ent., LX: 226.
Canada (1).

## Family **NOTONECTIDAE**

*Notonecta irrorata* Uhler
1879. Proc. Boston Soc. Nat. Hist., XIX: 443.
Pennsylvania (8); Ohio (19); Tennessee (26).

*Notonecta uhleri* Kirkaldy
1897. Ann. Mag. Nat. Hist., ser. 6, XX: 58.
South Carolina (28ab).

*Notonecta unifasciata andersoni* Hungerford
1933. Kansas U. Sci. Bull., XXI No. 9: 110.
Canada (1).

*Notonecta indica* Linné
1771. Mantissa plantarum ii: 534.
South Carolina (28c).

*Notonecta undulata* Say
1832. Heter. New Harmony, p. 39 (Fitch Reprint).
Canada (1); Pennsylvania (8, 11); Ohio (19, 20); California (36).

*Plea striola* Fisher
1844. Abh. bohm. Ges. Wiss Prag. (5) III: 18.
Canada (2).

## Family **NAUCORIDAE**

*Pelocoris femoratus* (Palisot de Beauvois)
1805. Ins. Rec. en Afr. et Amer., Paris, p. 237.
Florida (31b).

*Ambrysus mormon* Montandon
1909. Bull. Soc. Sci. Buc., 18: 48.
California (36).

## Family **BELOSTOMATIDAE**

*Benacus griseus* (Say)
1832. Heter. New Harmony, p. 37.
South Carolina (27).

*Belostoma fluminea* (Say)

1832. Heter. New Harmony, p. 38.

Canada (2); New York (3); Pennsylvania (7); Pennsylvania-Delaware (14); Maryland (18); Ohio (19, 20); Virginia (23, 24); Tennessee (26); South Carolina (28bcdef); Texas (34c).

*Belostoma lutarium* (Stal)

1855. Obv. Sv. Vet.-Ak Forh., 12: 190.

South Carolina (28a); Texas 34b).

*Belostoma bakeri* Montandon

1913. Bull. Soc. Sci. Bucharest. 22: 123.

Texas (34ab).

## Family **NEPIDAE**

*Nepa apiculata* Uhler

1862. *In* Harris, "Insects injurious to vegetation," 3rd ed., p. 12.

Ohio (19).

*Curicta howardi* Montandon

1910. Bull. Soc. Sci. Bucharest, 18: 181.

Texas (34c).

*Ranatra nigra* Herrich-Schaeffer

1853. Wantzenartigen Insecten, IX: p. 32.

Pennsylvania (10B); Maryland (18); Ohio (19, 20); Virginia (22, 23, 24); South Carolina (28def, 29e); Florida (31ab); Texas (32).

*Ranatra kirkaldyi* Bueno

1905. Can. Ent., XXXVII: 187.

South Carolina (28af, 29ab).

*Ranatra fusca* Palisot de Beauvois

1805. Ins. Rec. Afr. Amer., p. 235.

Canada (1); Pennsylvania (5).

*Ranatra australis* Hungerford

1922. Kansas U. Sci. Bull. XIV, No. 18: 449.

South Carolina (28c); Florida (31b); Texas (34abc).

*Ranatra buenoi* Hungerford

1922. Kansas U. Sci. Bull. XIV, No. 18: 442.

South Carolina (28a); Texas (32).

## Family **GELASTOCORIDAE**

*Gelastocoris oculatus* Fabricius

1798. Ent. Syst. Suppl., p. 525.

Maryland (18); Virginia (22); Tennessee (26); South Carolina (28abef, 29a); California (36).

## Family **OCHTERIDAE**

*Ochterus americanus* (Uhler)

1876. Bull. U. S. Geol. Geog. Surv. Terr., 1: 335.

South Carolina (29a).

## Family **GERRIDAE**

*Gerris alacris* Hussey

1921. Psyche, 28: 11.

South Carolina (28c).

*Gerris canaliculatus* Say

1832. Heter. New Harmony, p. 36.

Tennessee (26); South Carolina (28a).

*Gerris conformis* Uhler

1878. Proc. Bost. Soc. Nat. Hist., XIX: 435.

Pennsylvania (4, 8, 9, 10B); Pennsylvania-Delaware (14, 16); Tennessee (26); South Carolina (29a).

*Gerris comatus* Drake and Hottes

1925. Ohio Jour. Sci., 25: 48.

Canada (1, 2); New York (3); Pennsylvania (4, 7, 10B); Maryland (18); Ohio (19); South Carolina (27).

*Gerris dissortis* Drake and Harris

1930. Bull. Brook. Ent. Soc., 25: 145.

Canada (1, 2).

*Gerris incurvatus* Drake and Hottes

1925. Proc. Biol. Soc. Wash., 38: 72.

Ohio (19).

*Gerris marginatus* Say

1832. Heter. New Harmony, p. 36.

New York (3); Pennsylvania (8); Pennsylvania-Delaware (13); Maryland (18); Ohio (19, 20); Virginia (23); South Carolina (28f, 29c); Texas (34c).

*Gerris nebularis* Drake and Hottes

1925. Proc. Biol. Soc. Wash., 38: 70.

Virginia (23, 24); South Carolina (28abf, 29cf).

*Gerris remigis* Say

1832. Heter. New Harmony, p. 35.

New York (3); Pennsylvania (7, 8, 9, 10A, 12); Pennsylvania-Delaware (13, 14, 15, 16, 17); Maryland (18); Ohio (19); Tennessee (26); South Carolina (29e); California (36).

*Gerris gilletei* Lethierry & Severin

1896. Cat. Genl. Hemipt., 3: 60.

Texas (34b).

*Limnogonus hesione* (Kirkaldy)

1902. The Entomologist, 35: 137.

Texas (34bc).

*Metrobates artus* Anderson

1932. Jr. Kans. Ent. Soc., 5: 56.

Texas (34bc).

*Metrobates hesperius* Uhler

1871. Proc. Bost. Soc. Nat. Hist., XIV: 109.

Pennsylvania (6); Pennsylvania-Delaware (13, 14); Maryland (18); Ohio (19, 20); Virginia (21, 22, 23, 24); Tennessee (26); South Carolina (28abcef); Georgia (30); Florida (31a).

*Rheumatobates rileyi* Bergroth

1892. Ins. Life, 4: 198, 321.

Pennsylvania (9); Maryland (18); Ohio (20); Virginia (22, 24); South Carolina (28c).

*Rheumatobates hungerfordi* Wiley

1923. Canad. Ent., LV: 202.

South Carolina (28); Georgia (30); Texas (33, 34c).

*Rheumatobates tenuipes* Meinert

1895. Ent. Medd., 5: 7.

Tennessee (26); South Carolina (28ab); Florida (31a).

*Trepobates pictus* (Herrich-Schaefer)

1848. Wanz. Ins., 8: 111.

Pennsylvania-Delaware (13, 14).

*Trepobates inermis* Esaki

1926. Ann. Mus. Nat. Hung., 23: 4.

Pennsylvania (4, 6, 8, 9, 10A); Pennsylvania-Delaware (16, 17); Ohio (19, 20); Virginia (21, 22, 23, 24); Tennessee (25, 26); South Carolina (28abdef); Georgia (30); Florida (31b); Texas (34abc).

## Family **VELIIDAE**

*Microvelia americana* (Uhler)

1884. Stand. Nat. History, 2: 274.

New York (3); Pennsylvania (5); Pennsylvania-Delaware (16, 17); Virginia (21, 23); South Carolina (29a).

*Rhagovelia obesa* Uhler

1871. Proc. Bost. Soc. Nat. Hist., XIV: 107.

New York (3); Maryland (18); Ohio (19, 20); Virginia (22, 23, 24); South Carolina (28abdef, 29abcef).

*Rhagovelia oriander* Parshley

1922. S. Dak. State Coll. Tech. Bull., 2: 19.

Ohio (19, 20).

*Rhagovelia choreutes* Hussey

1925. Journ. N. Y. Ent. Soc., 33: 67.

Texas (34abc).

## Family **HYDROMETRIDAE**

*Hydrometra hungerfordii* Bueno

1926. Ent. Amer. Brooklyn (N.S.), 7: 107.

South Carolina (28cef); Florida (31b).

*Hydrometra martini* Kirkaldy

1900. Entom., 33: 175.

Pennsylvania (7, 8); Ohio (19, 20); Virginia (22); Tennessee (26).

## Family **MESOVELIIDAE**

*Mesovelia bisignata* Uhler

1883. Stand. Nat. Hist. 2: 274.

Canada (1, 2); New York (3); Pennsylvania (4, 6, 9, 10C); Maryland (18); Ohio (19, 20); Virginia (21, 22, 23, 24); Tennessee (26); South Carolina (28c); Texas (34c).

# THE BATRACHIDEINAE (ORTHOPTERA; ACRIDOIDEA; TETRIGIDAE) OF NORTH AMERICA

BY JAMES A. G. REHN AND HAROLD J. GRANT, JR.

*Department of Insects, Academy of Natural Sciences of Philadelphia*

This study, the eighth of our collateral papers on the Tetrigidae of North America, concludes our series on this family [1] preparatory to the production of the Tetrigidae section of the monograph on the Orthoptera of North America, which National Science Foundation grants are sponsoring. We have presented a general outline of this set of studies and the resulting monograph in our *Nomotettix* paper, and given acknowledgments of the vital assistance we have had, and are now receiving, from a number of institutions and agencies.

In the study of the present subfamily we have examined a total of 8692 pinned museum specimens from America north of Mexico, as well as extensive representations of *Tettigidea* and other strictly Neotropical genera of the subfamily from south of the United States. Of the total number of North American specimens examined 3750 are in the collection of the Academy of Natural Sciences of Philadelphia, and twenty other institutions, agencies or individuals are the owners of the remainder of the series we have had before us.

*Discussion of the Subfamily.*—The subfamily Batrachideinae is one of the few clearly definable components of the cosmopolitan family Tetrigidae. In general terms, its distribution is largely confined to the tropical regions of both Old and New Worlds,

[1] "The North American Tetrigid Genus Nomotettix"; Proc. Acad. Nat. Sci. Phila., CVII, pp. 1-34, 1 map, pls. I-III (1955). "Tetrix subulata as Occurring in North America"; *ib.*, pp. 145-165, 2 maps (1955). "On Tetrix brunneri and a New Species of Tetrix from California"; Proc. Acad. Nat. Sci. Phila., CVIII, pp. 97-115, 2 maps (1956). "The Components of Tetrix ornata"; *ib.*, CVIII, pp. 117-153, 14 figs., 2 maps (1956). "An Analysis of Tetrix Arenosa"; Trans. Amer. Entom. Soc., LXXXII, pp. 117-145, 8 text-figs., 1 map (1956). "A Review of the Genus Neotettrix"; *ib.*, pp. 217-250, 16 text-figs., 2 maps (1957). "The Genus Paratettix as Found in North America"; Proc. Acad. Nat. Sci. Phila., CIX, pp. 247-319, figs. 1-38, 3 maps (1957).

only three genera being known from temperate regions,[2] viz., *Saussurella* Bolívar which ranges from northern India through southern China to Taiwan (Formosa), *Paxilla* Bolívar endemic to the southeastern United States, and *Tettigidea* Scudder which is broadly distributed from Argentina to southern Canada. The greatest diversification of the batrachideines occurs in the Neotropical Region, where 11 of its 16 genera are found and where the great bulk of the species are concentrated. The North American representatives of the subfamily are clearly derived from South America.

The relationship of this subfamily to other subfamilies of the Tetrigidae is obscure. As a group it is well separated with no indications of even moderately close relationship with any of the other existing subfamilies, and until more fossil evidence is available its origin must remain a mystery.

Morphologically, the Batrachideinae may always be distinguished by the presence of a dorsal sulcation on the median femora, and, usually, of a similar sulcus on the cephalic femora although this latter character is sometimes obsolete in Neotropical genera. In addition, for the area here considered, the number of antennal segments is always greater (20-22) than that found in the Tetriginae (12-14). Supplementary characters which help to distinguish this group are: generally more robust body form; head generally larger and broader (especially interocularly), with the fastigio-facial angle less sharply defined; eyes proportionately less protrusive; possession of a medial, anterior pronotal spine by some species (not found in other tetrigids in the area).

The two elements of this subfamily found in the area under discussion are closely related. *Paxilla* appears to have been either derived from *Tettigidea* or the two genera had a common ancestor from which they both diverged. The possible origin of *Paxilla* may have occurred in the following manner. On one of the early intrusions of *Tettigidea*, or a *Tettigidea*-like form, into North America a certain element colonized southeastern United

[2] The Australian genus *Vingselina* Sjöstedt, placed by that author in the subfamily Batrachideinae, is not a member of this group, belonging instead to the subfamily Cladonotinae. See Rehn, The Grasshoppers and Locusts of Australia, vol. 1, pp. 25, 35, 36 (1952).

States including peninsula Florida, and probably extended further northward. Evidence, from our study of the North American species of *Tettigidea,* indicates that these invasions from the south were at least several in number (see discussion under the genus *Tettigidea*), and the probability exists that they were not sustained, but that southward retreats of the same elements also occurred. If a break in the continuous distribution of *Paxilla's* progenitor occurred, leaving populations isolated in extreme southeastern United States for a period of time sufficient for basic divergence to come about, possibly in both separated elements, before a new northward surge reunited them, then the two stocks could inhabit the same region with no interbreeding and subsequent loss of character. This would leave *Paxilla* the distinct and easily recognizable entity it is today. That this localization and separation of *Paxilla* from *Tettigidea*-like stock occurred in the distant past appears plausible, from the evidence offered by the various species of *Tettigidea* now extant. None of these species provides any evidence of convergence toward the unique morphology of *Paxilla,* and hence the relationship between the two genera is presumed to be an old one.

*Distribution of Subfamily in North America.*—The distribution of the Batrachideinae in our territory is encompassed by one of its component species (*Tettigidea lateralis*), which is discussed in detail under the distribution in the treatment of that species (see also maps 1 to 4).

## Key to the North American Batrachideine Genera

Body at most but moderately inflated, more attenuate, less definitely fusiform. Dorsal pronotal outline less regularly arcuate and relatively low, its elevation evident only in cephalic third or fourth; cephalic margin of disk occasionally (in *armata* and *acuta*) with a median spine. Caudal femora less robust, longer in relation to depth, at least 2.9 times as long as deep. Macropronotal or brachypronotal ..... *Tettigidea* Scudder

Body tumid, distinctly inflated, in build more fusiform. Dorsal pronotal outline strongly and more regularly arcuate, especially in cephalic half; cephalic margin of disk lacking a median spine. Caudal femora robust, shorter in relation to depth, 2.6 times as long as deep. Brachypronotal only ..... *Paxilla* Bolívar

### **Tettigidea** Scudder

1862. *Tettigidea* Scudder, Boston Journ. Nat. Hist., VII, p. 476.

Genotype (by designation of Rehn, 1904 [3]).—*Tettigidea lateralis* (Say).

The genus *Tettigidea* may be distinguished on the basis of the following characters: body generally robust in form; head proportionately large; eyes large and subprotruded, subtriangulate in basal lateral outline; antennae of moderate length with 20 to 22 segments; pronotum usually moderately tectate, usually arcuate cephalad in dorsal outline, occasionally almost plane; frequently with an anterior pronotal spine which is always projected forward but never rising over the head, usually possessing well-developed tegmina; cephalic femora with poorly developed or obsolete dorsal sulcus; median femora usually without an internal dorso-apical spine (spine, if present, much reduced); caudal femora robust; female subgenital plate entire, without a tooth-like median projection.

*Relationship.*—*Tettigidea* has no close relative outside South America except *Paxilla*, to which it is closely related, and with which it may share a common ancestry. The two genera are very similar in general facies, differing in the characters noted in the key to genera of North American batrachideines. In South America, where *Tettigidea* is the dominant genus in the subfamily, no other genus is as closely allied to it as *Paxilla*. Perhaps *Tettigidea's* closest relative in the Neotropical region is the widespread *Batrachidea* Serville whose species show some convergence toward it, being most like *T. armata* in their general form.[4] Other, more distantly allied genera are *Rehnidium* Grant and *Paurotarsus* Hancock [5], but these appear to be more closely related to other batrachideines than to *Tettigidea*. Because of its broad distribution, multiplicity of species and generalized morphology, *Tettigidea* may be regarded as an older phyletic line of the Batrachideinae, representing the evolutionary end-point of a stock which gave rise to several of the extant Neotropical genera.

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[3] Proc. Acad. Nat. Sci. Phila., 1904, p. 669.

[4] For a brief discussion of this relationship see Grant, Trans. Amer. Ent. Soc., LXXXII, p. 68 (1956).

[5] Trans. Amer. Ent. Soc., LXXXII, pp. 92, 93 (1956). Notulae Naturae, Acad. Nat. Sci. Phila., no. 275, p. 2 (1955).

*Distribution of Tettigidea.*—In North America its extreme limits are indicated by those of *T. lateralis,* which is discussed in greater detail on a following page, its extreme points from the Atlantic and Gulf coasts northward being Nova Scotia, and southern Quebec, Ontario and Manitoba, and its western ones on the Great Plains of western Nebraska and eastern Colorado, in the cordilleran mountains of north and south-central New Mexico and in extreme southeastern Arizona. Southward the genus ranges over most of Mexico and Central America, reaching the Pacific drainage first in the states of Nayarit and Jalisco, Mexico, and also extends broadly over the greater part of South America, south as far as southern Brazil (Rio Grande do Sul), Paraguay and the northern Argentine provinces and territories of Jujuy, Salta, Tucuman, and Misiones. It is not known from Chile, from the arid portions of western South America, nor from any considerable elevation in the Andean region, although it is widely spread from the lower eastern slopes of the Andes across Amazonia and the Guianas, as well as over the Paraguay-Paraná section of the La Plata system. It is also known from Cuba and Trinidad.

*Probable Pleistocene, Post-glacial and early Recent History in North America.*—It is clearly evident that *Tettigidea* entered North America from the southward, as the genus is a dominant member of the tetrigid fauna of the Neotropical Region. Its appearance in our area was undoubtedly preglacial, and in two or more incursions, the first, or at least all but the last, made up of the progenitors of *prorsa, empedonepia, armata* and *acuta.* These entities undoubtedly developed their specific characteristics in the southeastern and south-central United States, an area which has witnessed numerous similar instances of subsequent speciation from intrusive Neotropical stocks. Whether the ancestral lines of these species reached southeastern North America at the same time, or at well-spaced intervals, or with the progenitor of *Paxilla,* cannot be determined from present evidence.

The line of the genus represented by *T. lateralis* undoubtedly represents a later, more adaptable, intrusion, which preglacially probably spread over much or all of the territory now occupied by it. The Pleistocene glaciations in all probability removed the

species from much of the more northern territory it had occupied, and by driving wedges of glacial ice, and their accompanying climatic conditions, deeply into the Mississippi Valley lands divided much of the previous range of the species, started differentiating influences which resulted in the formation of two lines in *lateralis*. This narrowing of the former range apparently pushed into the more southern, eastern and southeastern United States typical *lateralis* as we here understand it, while the representative present in the eastern elements of the Cordilleran region, and much of the higher Great Plains became the typically well-differentiated *T. l. cazieri*. The amelioration of glacial conditions allowed each of these elements, which had not been separated long enough to have become specific entities, to reoccupy large areas which had been occupied by the ice, and the pattern we see today is a reflection of their reoccupation, which probably is still in progress. Typical *l. lateralis* has not been restricted by elevations, or their climatic corollaries, being found to the top of the highest mountains in the southeastern United States, while the *cazieri* influence has spread so broadly, and so greatly influenced the population reoccupying recently glaciated land, that material from those portions of southern Canada where *lateralis* occurs, as well as from the northern points of its distribution in the United States, is intermediate between the two subspecies, while to the south of this area we find a belt occupied by atypical *lateralis*, this being largely the southern section of territory which had been glaciated, although many of the localities represented by atypical *lateralis* are in unglaciated areas. Extending from this belt of atypical *lateralis* southward and eastward is the broad sweep of country which is the home of typical *lateralis*, and there it is found in a variety of conditions, and at elevations reaching from sea-level to the summit of the highest points in the southern Applalachians (Clingman's Dome at 6600 feet).

It is possible the presence of atypical *lateralis* indicates the extent to which post-glacial climatic alternations of warmer or colder conditions has taken place, in the fluctuating adjustments to which much of the territory now inhabited by atypical *lateralis* has been subjected. Considerable which we have already presented along these lines relative to *Tetrix o. ornata* and *T. o. hancocki*[6] applies equally to *Tettigidea lateralis*. The situation

[6] Proc. Acad. Nat. Sci. Phila., CVIII, pp. 119-122 (1956).

is not a static one, as what we have before us today is merely the status quo. Whether the two lines of *lateralis* become more divergent, or lose their identities in a more completely unified species, remains for the future to determine.

## Key to North American Species of Tettigidea

1. Neotenic; lacking a distinct tegminal sinus of the caudal margin of the lateral lobes of the pronotum. (Southeastern United States, i.e. northern Florida.) ..... *empedonepia* Hubbell

With normally developed tetrigid tegmina; with a well-indicated tegminal sinus of the caudal margin of the lateral lobes of the pronotum ..... 2

2. Cephalic margin of pronotal disk possessing a definite cephalad-directed cuspidate point or process ..... 3

Cephalic margin of pronotal disk not possessing a definite cuspidate point or process, instead being arcuate or obtuse-angulate ..... 4

3. Median carina of pronotum less cristate, more evenly arcuate and usually, in dorsal outline, without an emargination over the tegmina; surface texture of pronotum granulose, but smoother than in the following species, somewhat polished, with numerous, often poorly developed, anastomosing rugulae. (Eastern and southeastern United States from New Jersey to southern Florida, coastwise along Gulf to southern Louisiana.) .... *acuta* Morse

Median carina of pronotum more pronouncedly cristate, imperfectly arcuate and usually, in dorsal outline, with a marked emargination over the tegmina; surface texture of pronotum usually coarsely granulose, seldom shiny, with prominent and more easily distinguishable rugulae which are few in number. (Southern New York (Staten Island) and northern New Jersey to southern Florida, westward to eastern Texas and Oklahoma, and northward over the Mississippi Valley and Great Lakes region to northern Illinois, Indiana and Ohio, and southern Michigan.) ..... *armata* Morse

4. Head seen from the dorsum acuminate, as a whole narrowing to the median carina of the definitely angulate fastigium as seen in the same aspect, frontal carinae of the fastigium nearly (♂) or quite (♀) straight oblique convergent mesad. Fastigio-facial angle in profile sharper and more narrowly marked. Tegmina more elongate and narrower, more acute distad. (Eastern and southeastern United States from New Jersey to north-central Florida, west to northern Tennessee and eastern Louisiana.) *prorsa* Scudder

Head not at all acuminate, the eyes more prominent and the fastigium more transverse in general form, its frontal carinae not straight oblique convergent mesad. Fastigio-facial angle in profile more rounded and less sharply marked. Tegmina shorter and broader, blunter distad ..... 5

5. Eyes prominent and more globose; interocular space narrower as seen in cephalic aspect; median carina of fastigium thinner; frontal costa averaging narrower; head across the genae proportionately narrower as contrasted with breadth across eyes (see figs. 1, 3). (Typical area: Eastern and southeastern United States north to the Delaware Valley, southern Ohio and Illinois, west to east-central Texas.) .... *lateralis lateralis* (Say) [7]

Eyes less prominent and less globose; interocular space broader as seen in cephalic aspect; median carina of fastigium thicker; frontal costa broader; head across the genae proportionately broader as contrasted with breadth across eyes (see figs. 13, 15). (Typical area: Cordilleran region and plains from Nebraska and Colorado to New Mexico and southeastern Arizona.) ..... *lateralis cazieri* new subspecies [7]

*Material examined.*—We have had before us in the study of *Tettigidea* 8329 specimens from localities north of Mexico. These represent 6877 of the two subspecies of *T. lateralis*, 37 of *T. empedonepia*, 518 of *T. prorsa*, 149 of *T. acuta*, and 748 of *T. armata*. The two largest representations, comprising together over four-fifths of the material examined, are the property of the Academy of Natural Sciences of Philadelphia and the Museum of Zoology of the University of Michigan. The remainder of the representation studied was loaned by twenty other institutions or individuals, to all of whom we are deeply indebted, and thanks for this continued cooperation have already been expressed. A total of 1077 localities were tabulated in the specific studies, 885 of these for *T. lateralis* alone, with *armata* represented by 131 localities, *acuta* by 31, *prorsa* by 29, and *empedonepia* by one.

**Tettigidea empedonepia** Hubbell

*Tettigidea empedonepia* Hubbell, Occ. Pap. Univ. Mich. Mus. Zool., no. 350, p. 2, figs. (1937) [♂ (*type*), ♀; "Camp Torreya" ravine, Liberty Co., Florida].

This species is known from the type series [8] only and we can add nothing further to the excellent description and related remarks of Hubbell.

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[7] The differential features here given have been drawn from typical representatives of each of these subspecies. Intermediate individuals, or those atypical of each, will show transitional conditions in the features here cited. This is much more fully presented in the treatment of *T. lateralis* on a following page.

[8] Thirty-seven specimens of the type series (total 137) are now before us.

The relationship of *empedonepia* is clearly with the Mexican *T. bruneri* Morse[9] and the Mexican and Central American *T. nicaraguae* Bruner,[10] as stated by Hubbell, with somewhat closer relationship to the former. The neotenic character of *empedonepia* will, however, at once separate that species from its above-mentioned relatives. In addition *empedonepia* differs from *bruneri* in the slightly more protuberant fastigium of the female as seen from the dorsum, with its lateral carinae slightly more oblique in the same view, in the less deeply sulcate frontal costa of the same sex, in the more bullately rounded fastigio-facial angle and the dorsal section of the facial outline, with the median carina of the fastigium somewhat thicker and coarser, in the less sinuate dorsal outline of the pronotum as seen in profile, in the proportionately smaller and less prominent eyes as seen in all aspects, in the distal section of the dorsal ovipositor valves in profile narrowing more sharply to the apex, in the distal margin of the subgenital plate of the female being produced and rounded rectangular with a narrow median truncation as opposed to non-produced and entirely transverse truncate, and in the ventral outline of the caudal femora being definitely flatter and less arcuate than in *bruneri*.

Apparently *empedonepia* represents a line of the genus more broadly developed south of our borders, and it is quite probable that the incursion which brought this stock into North America was relatively old, possibly Pliocene, and that *empedonepia* is but the surviving remnant with a now greatly restricted distribution.

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[9] Biol. Cent.-Amer., Orth., II, pp. 15, 16 (1900) [♂, ♀ – Mexico]. Lectotype here designated: ♀; "Mexico. April," labelled in Morse's handwriting "Tettigidea bruneri Morse. Type '99." Received as part of the Bruner Collection. A.N.S.P. Type no. H 230. It is a brachypronotal individual in perfect condition except for the loss of the left antenna and right caudal tarsus. The Academy also contains a paratypic female bearing the same locality information, and an additional female taken at Orizaba, Mexico, by Sumichrast.

[10] Bull. Lab. Nat. Hist. State Univ. Iowa, III, p. 62, pl. III, figs. 3a and 3b (1895) [♂ (*type*), ♀; Nicaragua]. The lectotype of this species was designated by Hebard in 1932 (Trans. Amer. Entom. Soc., LVIII, p. 229) as the male of the original pair, both of which are before us. The lectotype is A.N.S.P. Type no. H 231.

**Tettigidea lateralis** (Say)

This species is composed of two subspecies, which typically occupy quite distinct zoogeographic areas, but between which there is a broad area of intergradation, as well as relatively narrower ones occupied by atypical individuals of each. Our interpretation of the background for this situation has been given under the generic discussion. The more evident characters distinguishing the two subspecies of *lateralis* have been given in the key to the forms of the genus, and are discussed more in detail under *T. l. cazieri.*

*Distribution.*—The range of *Tettigidea lateralis* in North America north of Mexico embraces that of its two components in that area, i.e. *T. l. lateralis* and *T. l. cazieri,* the latter described on a following page. We present first the limits of the collective distribution, i.e. that of the species, and then discuss the areas represented by individuals intermediate between the two subspecies, and by those of atypical and typical *l. lateralis,* the distribution of *T. l. cazieri* and its atypical representatives being considered under that subspecies.

The northern limits of *T. lateralis* known to us are in southern Manitoba (Winnipeg and Reynolds), southern Quebec (the northernmost Lanoraie), southern Maine (the northernmost before us being Orono), with a single record from central Nova Scotia (South Milford). To the southward the species reaches to southern Florida and extends westward over the Gulf Coast area of the United States at least as far as Kingsville, Texas. Eastward it covers the Atlantic coastal border from Nova Scotia and Maine to southern Florida. To the westward its limits known to us are Winnipeg, Manitoba; Martin, South Dakota; Scott's Bluff, Nebraska; Wray and Walsenburg, Colorado; Jemez Hot Springs, Sandoval and Albuquerque, New Mexico; and areas in the lower sections of the Chiricahua Mountains of Cochise County, southeastern Arizona. The extent to which *lateralis* penetrates into Mexico is not definitely known, but it clearly extends well into that country. It was first reported from Cuba by I. Bolívar,[11] and we have before us Cuban mate-

[11] Ann. Soc. Entom. Belg., XXXI, p. 298.

rial, in the Academy series,[12] which is typical *T. l. lateralis.*

The area of intergradation between *T. l. lateralis* and *T. l. cazieri,* as these entities have been evaluated by us, extends over a broad sweep of territory including the whole range of the species in southern Canada, except for a few points in extreme southern Quebec (Hemmingford) and Ontario (Vineland, Ridgeway, Mer Bleu, Turkey Point, Kingsville, Wheatley, Leamington and Point Pelee), where atypical *l. lateralis* occurs, thence southward to extreme northeastern New York (Peru), over the greater part of New England south to elevated northwestern Connecticut (Canaan), south-central Michigan (extreme southern points Clinton, Saginaw, Lapeer and Sanilac counties), extreme northeastern Illinois (McHenry, Lake and Cook Counties), over the greater part of Iowa (except that immediately adjacent to the Mississippi River and certain of its principal tributaries there, as the Iowa and Des Moines Rivers), the eastern section of South Dakota and Nebraska, areas of western and northeastern Kansas, eastern and east-central Oklahoma, and Texas west to Hemphill, Howard, Jeff Davis and Val Verde counties.

The atypical condition of *T. l. lateralis* is present over a relatively narrow belt of country between the territory occupied by the intermediate condition and that of typical *l. lateralis.* This reaches from coastal Maine and eastern Massachusetts, over most of Connecticut, New York, Pennsylvania except for narrowly along the Delaware River, northern and south-central New Jersey, certain areas in montane eastern and south-central West Virginia, includes the greater part of Ohio, much of northern and central Indiana, northern and central Illinois, all of Wisconsin, southeastern Minnesota (adjacent to the Mississippi River), the eastern section of Iowa, northeastern Missouri (Platte Co.), a number of points in eastern Oklahoma, and a section of northern and central Texas reaching from Cooke and Grayson counties south-southwestward to Real and La Salle counties. The entire range of the species south and east of this relatively narrow belt of atypical *l. lateralis* is populated by typical *lateralis.* Reference should be made to the accompanying map of the

[12] 7 kiloms N. of Vinales, Pinar del Rio Prov.; IX, 16-22, 1913; 1 ♂. Havana; (C. F. Baker); 1 ♂. Santiago, Oriente Prov.; VIII, 21, 1920; (M. Hebard); 1 ♀.

combined and evaluated distribution of *lateralis* (map 1) for a graphic presentation of the details here summarized.

Zonally *Tettigidea lateralis* is almost entirely Transition, Upper Austral, Lower Austral and Sabalian, also occurring in southern Florida in the area there generally regarded as Tropical. It is areally intrusive into sections which are or were originally Canadian Zone (Boreal) on the Georgian Bay district of Ontario and in parts of the northern section of the lower peninsula of Michigan. In limited areas, as on the summit of Clingman's Dome, Great Smoky Mountains National Park, it also penetrates into definitely Canadian spruce forest conditions. The same is doubtless also true at some of the more northern localities from which it is known.

Map. 1. The distribution of *Tettigidea lateralis* and subspecies. Filled circles = typical *Tettigidea lateralis lateralis;* circles with right half filled = atypical *Tettigidea l. lateralis;* circles with left half filled = atypical *Tettigidea l. cazieri;* unfilled circles = typical *Tettigidea l. cazieri;* circles with horizontal line = intermediate between *Tettigidea l. lateralis* and *Tettigidea l. cazieri.*

Its vertical distribution varies areally, but it is known to reach 6600 feet on Clingman's Dome, as mentioned above, and it has been taken at numerous localities in West Virginia, North Carolina and northern Georgia exceeding 4000 feet elevation. To the northward the highest elevations from which we have seen the species are Mt. Washington, New Hampshire, Mt. Toby, Massachusetts, and the summit of White Face Mtn., Adirondack Mts., New York at 4800 feet.

**Tettigidea lateralis lateralis** (Say) Text-figs. 1-9; Plate I, figs. 1-3, 6-8.

*Acrydium laterale* Say, American Entomology, I, pl. 5, upper and right figures (1824) [Probably ♂; Georgia and East Florida (here restricted to latter)].

*T[etrix] polymorpha* Burmeister, Handb. der Entom., II, abth. 2, pt. 1, p. 659 (1838) [♂, ♀; South Carolina ("von Zimmermann," probably vicinity of Georgetown[13])].

*Tetrix parvipennis* Harris, Treatise Insects N. E. Injur. Veget., 1st ed., p. 152 (1842) [Massachusetts by inference].

*T[ettigidea] parvipennis pennata* Morse, Journ. N. Y. Entom. Soc., III, p. 109 (1895) [Based on the macropronotal form of *parvipennis*, no localities cited].

*Tettigidea medialis* Hancock, Tettig. N. Amer., pp. 40, 140, 152, 165, pl. X, fig. 10 (1902) [♀ figured, Knoxville, Tenn. given as locality for same in explanation of plates (p. 188), other localities listed for this (p. 165) are "Central Missouri; Washington, D. C.; Baden, Mo.; Virginia; Georgia; Indiana"].

*Acrydium laterale* Say. The figured and described specimen is probably a male. Of the two localities given East Florida can be regarded as the here-selected original locality. Say's original material is not in existence, but considerable material from the general area of the restricted type locality is before us.

*Tetrix polymorpha* Burmeister. This name was based on two varieties, one macropronotal ("A"), the other brachypronotal ("B"), the former with two subvarieties, the latter with three of the same category. These minor categories were not named and were based on sexual or genetic color phases of this species. The synonymy of *polymorpha* under *lateralis* has been established for many years. The general relation of the two names was discussed anew by Rehn and Hebard in 1916.[14]

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[13] See Rehn and Hebard, Trans. Amer. Entom. Soc., XLI, p. 34 (1915) and XLII, p. 53, footnote 18 (1916).

[14] Proc. Acad. Nat. Sci. Phila., 1916, p. 150.

*Tetrix parvipennis* Harris. This name was based on the brachypronotal phase of the species, and presumably on Massachusetts material which represented either atypical *l. lateralis* or intermediate between *l. lateralis* and *l. cazieri,* in one or the other of which categories falls all the Massachusetts material examined. The original Harris material is not now in existence. While some authors, including Rehn and Hebard in 1916,[15] have regarded *parvipennis* as representing a valid northern geographic subspecies of *lateralis,* the definition of *T. l. cazieri* and the detailed study of its broad area of intergradation with *T. l. lateralis,* which the present analysis has made necessary, shows that *parvipennis* cannot be maintained, as the area from which it was described is one in which we find a definite passage from atypical *T. l. lateralis* to a condition intermediate between *T. l. lateralis* and *T. l. cazieri,* this zone of transition extends far westward across the northern United States and southern Canada.

*Tettigidea parvipennis pennata* Morse. This name was based on the macropronotal phase of what Morse regarded as Harris' *parvipennis.* No localities were originally cited, and no type designated, while no material authentically labelled is contained in any collection we have examined. The name was placed in synonymy by Rehn and Hebard in 1916.[16]

*Tettigidea medialis* Hancock. In the Hancock series is a single female, hand labelled for locality and date by Hancock, " Knoxville, Tenn. 6/93," which agrees minutely with the figure of this species originally given by that author (pl. X, fig. 10). This we are here indicating as the single type on which this name was based. It is now Type no. 5805 Academy of Natural Sciences of Philadelphia. It represents typical *T. l. lateralis* as understood by us.

*Pronotal dimorphism.*—In *Tettigidea lateralis* the long pronotum form (macropronotal) is predominant with 69% of the recorded adult specimens being of this type. The character appears to be clinal in its expression in a north to south direction with the short pronotum form (brachypronotal) predominating in the northern part of the range. However, an apparent reversal

[15] Proc. Acad. Nat. Sci. Phila., 1916, p. 150.

[16] Proc. Acad. Nat. Sci. Phila., 1916, p. 150.

of this trend occurs in the southwestern part of the species' range inhabited by *T. l. cazieri* n. ssp., where the brachypronotal form overwhelmingly predominates. The percentage of macropronotal individuals by states and Canadian provinces follows:[17] Quebec, 35%; Ontario, 39%; Maine, 34%; New Hampshire, 38%; Massachusetts, 25%; New York, 49%; New Jersey, 93%; Pennsylvania, 57%; Ohio, 65%; West Virginia, 48%; Virginia, 54%; Kentucky, 54%; North Carolina, 61%; Tennessee, 69%; South Carolina, 94%; Georgia, 82%; Florida, 81%; Alabama, 82%; Mississippi, 69%; Michigan, 47%; Indiana, 76%; Illinois, 73%; Iowa, 50%; Nebraska, 56%; Missouri, 73%; Arkansas, 97%; Oklahoma, 79%; Louisiana, 92%; Texas, 76%; New Mexico, 14%; Arizona, none.

Laboratory populations used in conjunction with studies on the inheritance of color and color pattern, appear to demonstrate the genetic status of this character. According to Nabours and McQueen,[18] Good,[19] and later Nabours and Stebbins,[20] the short wings and pronotum of *T. parvipennis* [= *T. lateralis*] is a Mendelian character controlled by a single pair of genes. The breeding experiments show that "short [pronotum and wings] was undeviatingly dominant," and that it followed, in general, the anticipated Mendelian ratios. Quite the reverse is noted in natural populations (see above) where at only two points in the periphery of the range do we find brachypronotal specimens dominant in numbers. One obvious explanation is that, in nature, the brachypronotal condition is selected against, and that individuals possessing this character tend to be eliminated from the biota—possibly through increased predation. Apparently, however, the possession of short wings and pronotum is not a critical factor in the species survival. If it were we could expect its quick elimination from the species' genotype especially in consideration of the genetics of the situation, viz., 1) all long wing pronotum individuals are homozygous recessive for this character, 2) insects of this genetic constitution have almost

[17] In a few cases, series were too small to yield significant results and these are not included in the analysis.

[18] Records Genetics Soc. Amer., 6, 161 pp. (1937).

[19] Trans. Kansas Acad. Sci., 44, pp. 235-236 (1941).

[20] Journ. Exp. Zool., 124, p. 4 (1953).

three times as great an opportunity to mate with similar individuals than otherwise, 3) only one out of three of the brachypronotal specimens (about 10% of the total population) is homozygous for this condition. Much more extensive biological work is necessary before we can fully understand the complex problem of pronotal length and the factors which affect it.

*Morphological variation.—Tettigidea lateralis,* in common with many widespread species of North American tetrigids, presents a highly variable morphological facies. The difficulty of interpreting such species in systematic analyses is attested to by the large number of synonyms coined over the years and by the wholesale misdeterminations so apparent in the literature. We have been fortunate in having examined a very large series from over the entire range of this species, and also in having before us most of the types and previously recorded specimens. In the following discussion, *T. lateralis* is treated as a single unit with special emphasis being given to those characters which permit the recognition of its subspecies.

The chief characters which vary in this species are: height of the vertex over the dorsal eye surface; extent to which the frontal costa, in lateral outline, protrudes before the eyes; form of the frontal costa, in frontal aspect; relative size of the eyes and degree to which they protrude; form of the anterior pronotal border; dorso-lateral pronotal outline; pronotal sculpture.

The height of the dorsal surface of the vertex in relation to the dorsal eye surface is one of the most variable features found in this species. The vertex is nearly always domed and in the great majority of specimens exceeds the dorsal surface of the eyes. Typical *lateralis lateralis,* especially in the southeastern part of its range, exhibits a lower vertex, and many specimens (particularly males) have the surface of the vertex on the same level as the dorsal surface of the eyes. This character cannot be used to differentiate the two subspecies because typical *lateralis cazieri* also possesses a weakly domed and lower vertex, which in some males is no higher than the dorsal eye surface. The condition of the vertex described above for some specimens of typical *l. lateralis* and *l. cazieri* represents one extreme of this character. The opposite development is one in which the dorsal vertex surface is

higher than the eyes by a distance equal to one-quarter the depth of one eye. A condition virtually intermediate between the extremes is found over the greater part of the species' range. We have not been able to correlate one or the other extreme of vertex development with any other morphological character.

In lateral outline, the slope and degree of protrusion of the frontal costa is another variable feature of *T. lateralis*. This character possesses some value as a criterion for separating the two elements of the species. The extremes in shape and protrusion of the frontal costa are well marked by typical *l. cazieri* and *l. lateralis*. The former subspecies possesses an evenly arcuate costal outline which protrudes anteriorly before the eye, just below the level of the paired ocelli, a distance equal to one-third to one-half the width (measured as the greatest antero-posterior distance in lateral aspect) of one eye, the mean distance being much closer to one-half the width of an eye. Typical *l. lateralis* has an arcuate costal outline which frequently tends to be slightly flattened in its upper half, and which protrudes before the eyes a distance equal to a little greater than one-quarter the width of one eye. Intermediate conditions predominate over much of the species' range.

The frontal costa, in frontal aspect, varies in its width throughout the range of *T. lateralis*. The lateral carinae are usually evenly divergent from the point at which they arise to the ventral extremity of the frontal costa. The range in width of the frontal costa (measured as the greatest distance between the outer margins of the lateral carinae) expressed as the ratio—width of fastigium/width of frontal costa—is 2.7-3.8. There appears to be little regional localization of either the broad or narrow frontal costa, but more specimens of typical *l. cazieri* possess an average broader frontal costa than is found in the rest of the populations studied.

The size of the eyes and the degree to which they protrude varies over the range of *T. lateralis*. The character is one which has great systematic value in separating the two subspecies recognized by us. Typical *l. cazieri* has the eyes much less protrusive and proportionately smaller than is found in typical *l. lateralis*. This character can be numerically expressed by dividing the total width of the head measured from above (including

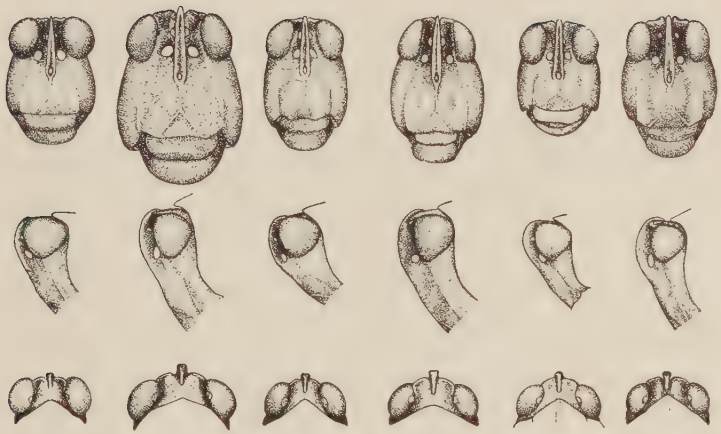
the eyes) by the width of a single eye (measured from above along a line drawn at right angles to the mesal border of the eye at its mid-point). Reference to table 1 will show the comparative ratios shown by this character in representative populations of the species. Figures 1 and 13 illustrate the two extremes of eye size and protrusiveness found in typical *l. lateralis* and *l. cazieri* (see also Plate I, figs. 1 and 5).

The shape of the cephalic pronotal border is variable in this species, but as a taxonomic character possesses no infraspecific value. The predominant condition is one which is moderately arcuate, though an almost equal number of specimens possess an angulate margin. Specimens with an arcuate border vary from an extreme which is almost parabolic in anterior outline (seen from above) to a very low, sub-arcuate condition. These specimens with an angulate border show this structure produced and sharply angulate in one extreme and very lowly angulate and little produced in the other. Both extremes are found over the entire range of the species with no clinal pattern being evident.

In outline, the dorso-lateral pronotal margin is usually evenly arcuate throughout its entire length except for a very weak emargination over the tegmina. Variants occur over the species' range which lack the emargination entirely, while others have it strongly pronounced. Macropronotal specimens have a more nearly even pronotal arcuation while examples of the brachypronotal type tend to exaggerate this feature.

The normal surface condition of the pronotum is relatively smooth and set with many small irregularly placed pustules. The dorsal surface usually possesses a series of poorly developed rugulae which are directed antero-posteriorly. These rugulae sometimes anastamose, or they may run their entire lengths without joining each other. Variants show a surface which is smooth and almost lacking pustulae or rugulae while others have both these elements very well developed. There is no correlation between distribution and pronotal surface type.

*Size variation.*—Table 1 shows the variation in size of five characters from five representative populations of *Tettigidea l. lateralis*.



Figs. 1 to 18. Morphological aspects of *Tettigidea lateralis*. Fig. 1, upper row left, head, frontal aspect; Fig. 2, middle row left, head, left lateral aspect; Fig. 3, lower row left, head, dorsal aspect—all of typical *T. lateralis lateralis*, ♂, Welaka, Florida: Fig. 4, upper row second from left, head, frontal aspect; Fig. 5, middle row second from left, head, left lateral aspect; Fig. 6, lower row second from left, head, dorsal aspect—all of typical *T. lateralis lateralis*, ♀, Welaka, Florida: Fig. 7, upper row left center, head, frontal aspect; Fig. 8, middle row left center, head, left lateral aspect; Fig. 9, lower row left center, head, dorsal aspect—all of intermediate between *T. lateralis lateralis–T. lateralis cazieri*, ♂, Forest City, Iowa: Fig. 10, upper row right center, head, frontal aspect; Fig. 11, middle row right center, head, left lateral aspect; Fig. 12, lower row right center, head, dorsal aspect—all of intermediate between *T. lateralis lateralis–T. lateralis cazieri*, ♀, Forest City, Iowa: Fig. 13, upper row second from right, head, frontal aspect; Fig. 14, middle row second from right, head, left lateral aspect; Fig. 15, lower row, second from right, head, dorsal aspect—all of typical *T. lateralis cazieri*, ♂, paratype, Southwestern Research Station, Cave Creek Canyon, Cochise Co., Arizona: Fig. 16, upper row right, head, frontal aspect; Fig. 17, middle row right, head, lateral aspect; Fig. 18, lower row right, head, dorsal aspect—all of typical *T. lateralis cazieri*, ♀, paratype, Southwestern Research Station, Cave Creek Canyon, Cochise Co., Arizona. All figures greatly enlarged.

*Coloration, pattern and tone.*—The coloration of *T. lateralis* has been previously discussed at some length by Rehn and Hebard,[21] Bellamy[22] and Good.[23] These authors have described

[21] Proc. Acad. Nat. Sci. Phila., 1916, p. 152 (1916).

[22] Journ. Genetics, VII (1), pp. 55-70 (1917).

[23] Trans. Kansas Acad. Sci., 44, pp. 234-237 (1941).

various chromatomorphs, as well as the modes of inheritance of certain color characters in this species. The following paragraphs summarize their contributions and also include original observations.

This species is rich in color forms, twelve different ones being described by the above mentioned authors. We do not consider it worthwhile to describe any but the principal color forms, inasmuch as nearly every one of the non-unicolorous specimens differs in some details of its color pattern. The basic and predominant color types are only four in number:

1. Unicolorous black, gray, dark or light brown over most of the body. This is the commonest form occurring in slightly more than one-half of the specimens examined.
2. Dorsum of pronotum lighter in color than the rest of the body. The light area may be cream, tan or cinnamon-brown. Approximately 40% of the present series exhibits this coloration.

| | Albuquerque, N.M. and Chiricahua Mts., Arizona (♂) (typical T.l.cazieri) | | Lincoln, Nebraska (atypical T.l.cazieri) | | Forest City, Iowa (intermediate T.l.cazieri - T.l.lateralis) | | E.S.George Res. Michigan (atypical T.l.lateralis) | | Welaka, Florida (typical T.l.lateralis) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| Length of body | 9.7 | 12.2 | 8.9 | 12.0 | 9.0 | 10.8 | 9.6 | 12.3 | 8.5 | 12.3 |
| | 9.0 | 12.0 | 10.0 | 12.7 | 8.5 | 10.2 | 9.2 | 12.0 | 7.9 | 12.5 |
| | 8.5 | 12.5 | 9.6 | 11.7 | 8.5 | 10.0 | 9.1 | 11.4 | 9.6 | 12.8 |
| | 8.4* | 11.2 | 9.9 | 12.5 | --- | 10.1 | 9.0 | 10.9 | 8.3 | 12.2 |
| | 8.4* | 10.7 | --- | 12.0 | 9.1 | 11.1 | 8.4 | 10.5 | 8.4 | 12.0 |
| Length of pronotum | 8.2 | 12.0 | 8.7 | 12.0 | 7.7 | 11.0 | 10.9 | 13.0 | 9.2 | 9.8 |
| | 8.3 | 11.9 | 11.0 | 12.0 | 7.7 | 9.0 | 11.3 | 14.2 | 8.0 | 10.1 |
| | 8.1 | 11.9 | 11.1 | 11.8 | 8.1 | 10.1 | 10.4 | 11.8 | 10.1 | 10.4 |
| | 7.5* | 10.0 | 10.6 | 14.5 | 8.0 | 9.5 | 7.9 | 9.8 | 7.0 | 11.7 |
| | 7.4* | 10.7 | --- | 13.7 | 10.0 | 11.7 | 7.2 | 9.5 | 7.1 | 11.8 |
| H/E ratio | 3.67 | --- | 3.41 | 3.84 | 3.34 | 3.87 | 3.28 | 3.73 | 3.00 | 3.25 |
| | 3.53 | 3.90 | 3.49 | 3.95 | 3.25 | 3.81 | 3.21 | 3.81 | 3.03 | 3.21 |
| | 3.45 | 4.16 | 3.32 | 3.90 | 3.30 | 3.62 | 3.25 | 3.58 | 3.00 | 3.35 |
| | 3.53* | 4.03 | 3.37 | 3.71 | 3.63 | 3.75 | 3.28 | 3.54 | 3.18 | 3.10 |
| | 3.47* | 3.84 | --- | 3.87 | 3.36 | 3.57 | 3.30 | 3.37 | 3.05 | 3.12 |
| Length of posterior femur | 5.7 | 7.6 | 5.7 | 7.0 | 5.2 | 6.7 | 6.1 | 7.3 | 5.1 | 6.7 |
| | 5.6 | 7.6 | 5.8 | 7.0 | 5.1 | 6.6 | 5.8 | 7.6 | 5.0 | 7.1 |
| | 5.2 | 7.1 | 5.8 | 7.0 | 5.2 | 6.5 | 5.5 | 7.0 | 5.8 | 6.9 |
| | 5.2* | 7.0 | 5.7 | 7.6 | 5.4 | 6.4 | 5.6 | 6.3 | 5.1 | 6.9 |
| | 5.1* | 6.9 | --- | 7.5 | 5.6 | 6.4 | 5.4 | 6.7 | 5.0 | 7.0 |
| Greatest width of posterior femur | 2.0 | 2.6 | 1.8 | 2.5 | 1.8 | 2.3 | 2.0 | 2.3 | 1.6 | 2.4 |
| | 2.0 | 2.6 | 2.0 | 2.6 | 1.9 | 2.1 | 1.7 | 2.4 | 1.6 | 2.4 |
| | 2.0 | 2.5 | 2.0 | 2.5 | 1.7 | 2.1 | 1.8 | 2.3 | 1.9 | 2.3 |
| | 1.7* | 2.4 | 1.9 | 2.5 | 1.8 | 2.0 | 1.8 | 2.2 | 1.7 | 2.2 |
| | 1.8* | 2.5 | --- | 2.4 | 1.8 | 2.0 | 1.7 | 2.2 | 1.9 | 2.3 |

Table 1. Size variation in five populations of *Tettigidea lateralis*. H/E ratio is the total width of the head (including the eyes) divided by the width of one eye. All measurements are in millimeters.

3. Latero-dorsal edge of pronotum and anterior carinae lighter in color than the rest of the pronotum. This character occurs in specimens with either light colored or dark pronota. This chromatomorph is rare.
4. Posterior femora with a light spot or annulation. This is frequently encountered and occurs in combination with any of the patterns described above.

No one of the chromatomorphs is peculiar to any area of the species' range.

*Habitats.*—Morse, in 1894, when discussing this species [24] as found in New England, regarded it as "preferring moist, grassy and sedgy meadows, particularly on rather light soil . . . and even along roadside gutters on springy land, where the ground was moist and sandy." In 1904 he noted,[25] relative to *T. lateralis*, "Locusts of this genus are usually found most abundantly in moist or wet meadows and marshes, with soils of sandy loam, showing a preference for a habitat intermediate in degree of humidity between such species as *Nomotettix cristatus* and *Tettix ornatus* [i.e. *Tetrix ornata*] on the one hand and *Paratettix cucullatus* on the other." A few years later (1907) he mentioned it [26] as "occurring in countless numbers in wet bottom lands, along streams, and even at considerable elevations about springs, as on Magazine Mountain, Arkansas." Walker, in 1898,[27] noted that on April 12, 1895, in Ontario, he found a female of *lateralis* "hibernating in a beetle-boring in a log. The hole was completely concealed by the bark."

In 1903 Blatchley [28] considered it as "very common . . . throughout Indiana, frequenting both dry upland woods, fence rows, and low marshy tracts. It hibernates usually in small colonies or groups—as many as eleven having been found huddled together within the space of a few square inches on the underside of a log or chunk." Shull, in 1911, noted [29] that on the

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[24] Psyche, 1894, p. 161.

[25] Carnegie Inst. Wash., Pub. 18, p. 28.

[26] Carnegie Inst. Wash., Publ. 68, p. 27.

[27] Canad. Entom., 30, p. 124.

[28] 27th Ann. Rep. Dept. of Geol. Nat. Res. Indiana, pp. 231-232.

[29] Publ. 4, Biol. Ser. 2, Michigan Geol. and Biol. Survey, p. 223.

south shore of Saginaw Bay, Michigan, *lateralis* occurred in an "open grass plot in edge of damp woods," and "on sand beaches with or without vegetation."

Rehn and Hebard reported, in 1904,[30] "this species was very abundant in moist localities in Thomas [Georgia] and Leon [Florida] counties . . . in bottomland as well as on sandy stretches and moist meadow." In 1907 the same authors, relative to the species at Pablo Beach and Gainesville, Florida, said [31] individuals "were taken in swampland, palmetto scrub, in undergrowth in pine woods and on damp sand," and in 1916, they summarized [32] its general habitats in the Coastal Plain and Piedmont of the southeastern United States, as "distributed everywhere through grasses and herbage of meadow, forest, swamp and marsh, usually found most numerous in and about damp situations."

In 1920 Blatchley summarized the general habitats of the species in northern Indiana [33] as "dry upland woods, fence rows and low marshy tracts. . . . Its mating season appears to be the whole year round, as I have taken specimens in copulation in nearly every month, even on sunny days in mid-winter." Fox noted, in 1917,[34] that at Virginia Beach, Virginia *lateralis* was "occasional in open groves of pine (*P. taeda*) and sweetgum on fixed dunes," and at Charlottesville, Virginia, "common but somewhat local . . . in both woodland and campestral localities," while at Monterey, in the mountains of Virginia, it occurred in "dry, open woods on mountain slopes." Hebard, in 1915, recorded it [35] as found on "dark soil on the edge of [a] red mangrove swamp," at Brickell's Hammock, a locality now covered by the city of Miami, Florida. Morse, in 1920, recapitulated the habitat associations of the species,[36] as, "almost every place where there is a constant supply of moisture and bare soil for the

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[30] Proc. Acad. Nat. Sci. Phila., 1904, p. 782.

[31] Proc. Acad. Nat. Sci. Phila., 1907, p. 285.

[32] Proc. Acad. Nat. Sci. Phila., 1916, p. 151.

[33] Orth. N.-E. Amer., pp. 182-184.

[34] Proc. U. S. Nat. Mus., 52, p. 207.

[35] Entom. News, XXVI, p. 401.

[36] Orth. N. Engl., pp. 536-537.

growth of the minute vegetable organisms on which it feeds. . . . Though generally met with in but small numbers, a populous colony numbering into the hundreds is occasionally found." Hubbell, in 1922, noted *lateralis*[37] as found in a broad variety of habitats in Berrien Co., Michigan, all, however, very moist or adjacent to water except " open, grassy fields and forest margin thickets."

Cantrall in 1954 gave us very extensive observations on the species as present on the George Reserve in southern Michigan.[38] Much of his information, particularly that drawn from live laboratory material, is important and illuminating, but his assumption that Blatchley erred in regarding dry upland woods as a normal habitat for the species is unwarranted. Cantrall regards those so occurring as " erratic individuals," and assumes Blatchley's observations were made at other (i.e. late Autumn) than the optimum time of occurrence. The scores of observations and notes made by Hebard and Rehn, Rehn and Rehn, and the senior author alone, show conclusively that *lateralis* was taken many times in relatively dry woods or other dry situations in fifteen states in Summer and early Autumn, and that over much of the species' distribution it regularly occurs, and over an extensive period, in such situations. We have before us field notes on this species made at the time, by either the late Morgan Hebard or the senior author, relative to its occurrence at 179 stations in fifteen states reaching from New Jersey and Pennsylvania to Nebraska and New Mexico and Arizona, and from the two first mentioned states south to southern Florida, Alabama, Mississippi, Louisana and Texas. The conditions under which the species was collected—the material here recorded—at 87 of these localities were definitely dry, without juxtaposition to water or damp areas, and without indication of having recently dried out, as noted in the comments for other localities tabulated in the " wet " environment category. All of these " dry " localities represent dates in July, August and September, the greater part in August, and none in late Autumn. Most certainly the evidence here reviewed cannot be considered as based on strays or

[37] Occ. Papers Mus. Zool. Univ. Mich., 116, p. 34.

[38] Misc. Publ. Mus. Zool. Univ. Mich., 54, pp. 83-87.

"erratics," as far too large a percentage of the total occurred in proportionately dry situations.

What is apparent is clearly that the presence of the species in the drier situations is found more frequently to the northward, and much less so in the country adjacent to the Gulf Coast. However, this evidence is in no sense put forward as implying that the species is not basically attracted to situations in which moisture is a definite factor, as is true of most all tetrigids.

The analysis of the data from the 87 localities above mentioned shows that all included from Pennsylvania (7), Delaware (2), and Tennessee (12) noted *lateralis* as present in relatively dry situations, from West Virginia 8 of 12, Virginia 13 of 18, North Carolina 9 of 21, South Carolina 1 of 3, Georgia 3 of 7, Florida 5 of 33, Alabama 5 of 13, Louisiana 1 of 8, Mississippi 7 of 12, Kentucky 4 of 7, Arkansas 5 of 7 and Texas 5 of 11 similarly represented relatively dry situations. It is evident when the localities are plotted geographically that those at which the species was taken in dried environments are predominantly Piedmont or Appalachian, or at least more elevated than those of the Coastal Plain, in which latter broader areas of consistently moist character would be encountered.

The range of habitats in which *lateralis* has been encountered, and for which hitherto unpublished information is available, is so great that only some of the more characteristic and the most unusual can be mentioned. The "dry" situations cover old fields of this character, often grown up in thistle, blackberries, sumac, smilax, golden rod, wild strawberries and tall grass, these often bordering woodland, roadside weed tangles, wooded slopes and hilltops under maple, tulip poplar, oak, chestnut, sweet-gum and magnolia, with undergrowth often of alder or huckleberries, in mixed forest of various hardwoods and pine, occasionally on higher land with hemlock, on boulder strewn slopes and ridge summits, in pine-barren like conditions with bunch grass and *Cladonia,* on dry wood roads in deciduous forest and pineland, virtually bare sand in scrub oak on sand dunes (Carrabelle, Florida), in wire-grass, bayberry and saw-palmetto under longleaf pine, and on dry sand in the same type of forest, on the slab rock summit of mountains (Cheaha Mtn., Alabama), in mixed

low oak, sweet-gum and pine woods on loess bluffs (Natchez, Mississippi), on the dry sand of a coastal strand (Pass Christian, Mississippi), in grass and weeds with *Opuntia* (3 ms. E. of Bolivar, Tennessee), on ground in scrubby deciduous and red juniper woods on thin soil with limestone rock broadly exposed (4 ms. S. of Mountain View, Arkansas), and in a small clearing in dense spruce forest grown up in blackberries and sweet fern (summit of Clingman's Dome, 6600 feet, Great Smoky Mountains National Park).

The "wet" situations are equally varied, ranging from river banks of sand or mud, roadside drains or sloughs, these latter either wet or but recently under water, boggy spots in old fields, in relatively dry sphagnum bogs, in low damp spots with *Lycopodium*, with or without standing water, wet sand surface of roadside, fresh marsh area with grass and heavy weeds, in old dried-out pond bottom in an old field, in salt hay marsh, on wet sand flat with *Juncus, Drosera,* and *Lycopodium* close to salt marsh (2 ms. S. of Bethany Beach, Delaware), in heavy gum swamp with areas of high grass (Mobile, Alabama), among swamp vegetation in a cypress depression in longleaf pine flat woods (Irvington, Alabama), on bare damp black soil in area of marsh grass, mallows, willows and saw palmettoes (Orleans Canal, Louisiana), in coarse grass at edge of heavy tupelo gum and cypress swamp, in wet area of spring seeps from limestone outcrop (between Lamero and Mershons, Kentucky), in bottomland largely inundated and near much standing water (7.5 ms. S. of McGehee and 3 ms. S. of Gould, Arkansas), and, for *T. l. cazieri,* in grassland at bottom of canyon in Great Plains (Happy Crossing of Paloduro Creek, Texas). It is noted on material now before us, collected by others, as taken in a tamarack swamp (Hennepin Co., Minnesota), and in Spoon River drift and "on surface of Thompson's Lake" (Havana, Illinois).

This species has been taken in company with *Paratettix cucullatus, Nomotettix cristatus* and *Tetrix arenosa angusta* at localities in Pennsylvania, Kentucky and Tennessee, and with *Paxilla* at localities in Florida and Alabama.

Cantrall has stated [39] that "hibernation occurs beneath sticks,

[39] Misc. Publ. Mus. Zool. Univ. Mich., 54, p. 87 (1943).

stones, logs, and detritus; the insects simply crawl under any available shelter when the period of hibernation begins, usually in early November."

Hancock, in 1894, noted [40] that in September, 1893, at Chicago, Illinois, this species landed at night in swarms. First noticed on September 19, it occurred in such numbers that thousands were crushed under foot; again on September 21 additional multitudes were noted. The region involved covered "not only the City of Chicago, but the northeastern portion of Illinois and that part of Indiana including the lower bend of Lake Michigan adjacent." Observation showed that in the city of Chicago individuals of the locust had struck buildings on the north side of east and west streets, and Weather Bureau information established that on both dates the winds were from the southwest, south or southeast. The probable origin of the migrating grouse-locusts hence was probably to the southward. Rehn, in 1902, reported a similar migration at Philadelphia,[41] on September 24, 1902, when great numbers of the species were noted in various parts of the city.

*Seasonal Appearance.*—Hibernating overwintering individuals make it difficult to determine accurately, in tetrigids of temperate regions, whether under natural conditions they have one or two broods annually. Laboratory material, protected from the elements and other natural controls and hazards of various types, can supply data which conceivably may not reflect what would be found in a natural environment. On the other hand immature material is shunned by some collectors, and absence of it from a series is not proof it was not present when adults before us were taken. However, a very careful analysis has been made of all the dates represented in the extensive seris of *lateralis* before us, as well as their basis on adults, immature individuals, or both.

Hancock, as long ago as 1902, showed [42] that the time of incubation of *T. parvipennis* [= *lateralis*] in a vivarium was eighteen days, and individuals of this species hatched July 5, under the same conditions, had matured by August 27 to 29, or a post-hatching cycle of 53 to 56 days. This gives us, from experi-

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[40] Amer. Nat., XXVIII, pp. 483-487.

[41] Entom. News, XIII, p. 309.

[42] Tettig. N. Amer., pp. 178-179.

mental work, a probable lapse of 71 to 74 days between the laying of the egg and maturity of the individuals. Blatchley[43] has said of this species [as *lateralis parvipennis*], "its mating season appears to be the whole year round, as I have taken specimens in copulation in nearly every month, even on sunny days in mid-winter." Nabours, Larson and Hartwig stated in 1933 that[44] *T. parvipennis pennata* [= *lateralis*] was one of four grouse-locust species of which "four succeeding generations of any of these may be bred in the greenhouse within a year, as against one, or at best, only two generations annually of the more northern varieties and species of this subfamily." The inference here is that the present species of *Tettigidea* is not also a northern form, which the evidence here presented shows is hardly true, even though the genus is of austral derivation.

Cantrall has given us[45] extensive observations on the occurrence and actions of *T. lateralis* as found at the George Reserve in southern Michigan. Much of the material taken at the George Reserve, and now the property of the Museum of Zoology of the University of Michigan, has been used in the present study, and its occurrence information has been drawn upon in formulating the present conclusions.

It is clearly evident from the information now available that in the more northern portion of its range, and probably in most of the extreme western section of the same, this species is single brooded, but as more southern localities are reached it unquestionably is at least two brooded in natural conditions. To the northward it definitely passes through a hibernating, or at least "resting," period in mid-winter, usually as adults, but sometimes as immature individuals, although the latter contingency has been but rarely mentioned, and we have but little to support it in the material now before us. On warm sunny days in winter northward it will often become active, and the senior author recalls vividly having seen adults many years ago vigorously jumping on snow-dusted ground on February 22 at Philadelphia. To the southward, at least in the more southern United States, it probably does not really hibernate, but is active through the

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[43] Orth. N.-E. Amer., p. 183.

[44] Genetics, 18, p. 159.

[45] Misc. Publ. Mus. Zool. Univ. Mich., 54, pp. 84-87 (1943).

winter. Unfortunately early captures are rarely labelled as to whether the individual was active or torpid when taken. However, enough information is available to make evident that in the more southern United States the species is usually active throughout the winter.

From Canada we have before us adult material taken January 14 at Black Creek, Toronto, Ontario (but this may have been hibernating), and at nine localities during April in Ontario and Quebec, in June (19) at Reynolds, Manitoba, and July (10) at South Milford, Nova Scotia; adults and immature individuals were taken at Minette, Ontario on August 19 and on September 12 at North Bay in the same province. The last dates noted for Canadian adults are October 14 at De Grassi Point, Ontario, and October 30 at Winnipeg, Manitoba. These latter individuals were apparently active at the time of capture.

The earliest records of adults from New England on material before us is January 26, at Amherst, Massachusetts, this probably of hibernating individuals, the only date represented by both adult and immature individuals being August 16 (Woodstock, Vermont). Adult material from Ithaca, New York, now before us was taken as early as May 8 and as late as October 28, with other adults representing the months of July and September. Mated pairs were taken at Chestnut Hill, Philadelphia, Pennsylvania, as early as May 8, with other Pennsylvania adults secured as early as March 15 (Hummelstown), and as late as October 27 at Ashbourne, while adults and immature individuals were taken together as early as July 14 (Villa Nova) and as late as September 3 (Panther). The former of these localities is a dozen miles west of Philadelphia, while the latter is on the Pocono Plateau at an elevation of 2100 feet. This may indicate an approximate northern border for two annual broods in the eastern United States. In New Jersey the range for adults in the series before us extends from April 2 (Riverton) to October 8 (Atsion), with adults and immature individuals taken together July 6 (Sea Isle Junction) and August 5-6 (Ventnor). Mated pairs from Maryland are before us taken April 12 (Plummer's Island) and 19 (Cabin John), adults as late as December 14 (Forest Glen), while adults and immature individuals were taken

on August 10 (Chestertown). From Virginia adults and immature individuals were taken at six localities (Clinchfield, 1 m. W. of Tacoma, Collison Ridge, 5 and 6 ms. S. of Floyd, and 3 ms. E. of Willis) on dates between August 2 and 31, while material in the same conditions was taken as late as September 8 (Peters Mtn.).

In North Carolina the first date for adults before us is March 21 (Pisgah National Forest), the last for the same September 30 at Black Mountains, and October 10 at Southport, while adults and immature individuals were taken July 23 (Balsam), with other dates in July, August and September, to as late as October 1 at Mt. Pisgah. For South Carolina the first date for adults is February 1 (Florence), for immature individuals alone April 21 and 22 (Myrtle Beach), for adults and immature individuals August 26 (Along Rocky Bottom) and September 4 (Yemassee), while the last date for South Carolina adults is October 13 (Sumter). The first date for adults before us from Georgia is February 10 at Macon, the last adults December 7 (Macon) and 18 (Thomasville), while the first dates for adults and immature individuals taken together are June 10 at Sealey's Spring and 30 at Thomasville, with August and September dates for the same conditions represented by five localities, with October 9 at Macon the last for the two conditions taken together. We have adults and immature individuals taken at Sealey's Spring, Georgia, on June 10 and September 12, clearly showing two broods present there, while from Thomasville we have immature individuals alone taken February 29, March 18-25, April 9-10 and May 5.

In Florida the species clearly occurs adult and active all the year, with adult material before us taken from January 1 (Manatee) on, and Gainesville is represented by the same for all months through the year. Adults and immature individuals are before us from as early as January 3 (3 ms. E. of Sarasota) on, with dates representing March, April, May, June, July, August, September, October and early November (3), the latter at Payne's Prairie. From the Gulf States of Alabama, Mississippi and Louisiana the first adults before us were taken at New Orleans, Louisiana, on January 3, and the last date represented by the same type of material is in November (no date), captured at

Shreveport, Louisiana. Adult and immature individuals are before us taken both July 15 and August 25-27 at Mobile, Alabama, and as late as September 12 at Chattahoochee State Park, Alabama, and Strickton, Mississippi, September 15 at Brookhaven, Mississippi, and 16 at Breckenridge, Louisiana.

In the north-central United States we have the same type of transition from a single annual brood to two a year as noted in eastern areas from Pennsylvania southward. From Michigan the earliest date for adults we have before us is March 20 at the George Reserve, with adults alone from the same locality taken as late as September 30. We also have adults taken at East Lansing as late as November 13, adults and immature individuals are before us from the George Reserve taken August 7 and 30 and September 7, while immature individuals unaccompanied by adults are from the same locality taken November 2. From Illinois and Indiana we have adults representing dates as early as March 19 (Bloomington, Indiana) and 24 (Urbana, Illinois), and as late as December 15 (Urbana), while adults and accompanying immature individuals represent dates in August and September (Hanover, Indiana and Chicago, Illinois). Ohio apparently shows evidence of two annual broods, although this may be true only of the more southern half of the state. The first Ohio adults before us are dated March 17 (Colerain Township, Ross Co.), the last November 18 (Burlington Township, Licking Co.), while adults and immature individuals were taken together May 30-31 (Salt Creek Township, Hocking Co.), June 21 (Meredon), September 9 (Union Township, Clermont Co.), 16 (Bainbridge), 18 (Brush Creek Township, Highland Co.), and 23 (Wayne Township, Fayette Co.), October 10 ("Neotoma") and November 21 (same locality). From Tennessee we have the species present adult as early as February 12 (Clarksville) and occurring at the same place every month from March to October (17-24), while Tennessee adults and immature individuals taken together are before us from the following inclusive dates—June 17-22, July 4-20, August 5-28, and September 3-5, the locality Allardt alone being represented by July 20 and September 5, showing the probability of two broods at that point in the north-central part of the state.

From Minnesota the first adults before us were taken April 28, the last October 21. Iowa is represented by adults taken January 13-21 at Mount Pleasant, these probably being hibernating individuals, while the last date for Iowa adults is December 12 (Henry County). Missouri has January 19 (Atherton) as its first date for adults, and at the same locality it was taken adult as late as October 10-15; adults and accompanying immature individuals were captured on August 21 at Willard, where adults had been taken as early as March 31. The first adults before us from Arkansas were taken at Imboden on April 30, the last at the same place November 15, while we have adults and immature individuals taken at a number of Arkansas localities between August 10 and 30. For South Dakota the first date for adults we have is June 12, the last September 15, both taken at Springfield. In Nebraska the range in dates shown by adult material before us is between April 17 and September 24; in Kansas from January 23 to October 7-8 (these from Manhattan).

From Oklahoma the first date we have for adult material is March 8 (Stillwater), the last October 2 (Grove), while adults and immature individuals represent dates in August ranging from 13 to 30, the 26-29 representation (6.5 ms. NE. of Idabel), including three immature instars. In Texas the species is clearly at least two-brooded, the first date represented by adults being January 31 (San Antonio), two mated pairs were taken at Cotulla on May 11, the last adult was secured on December 15 (29 ms. NE. of Houston); adults and accompanying immature individuals taken together represent five months of the year, i.e. January 30 (Victoria), June 19 (15 ms. N. of Alpine), July 23 (Beaumont), August 2 (Tyler), September 2 (1.9 ms. E. of Trinity River), and 15 (Palmetto State Park).

The seasonal occurrence of *T. l. cazieri* is discussed under that subspecies.

Summarizing, it seems reasonably clear that typical *T. l. lateralis* is generally, if not always, two brooded, the intermediate condition between *T. l. lateralis* and *T. l. cazieri* appears to have but one annual brood, and atypical *lateralis* is more generally in the latter category. These conclusions would appear to support the postulate presented on another page as to the history of the species as a whole.

*Localities represented:* [46]

## Typical *T. lateralis lateralis*

PENNSYLVANIA: Cornwells (Bucks Co.) (1).

NEW JERSEY: *Atsion (Burlington Co.) (1). Hammonton (1), Ventnor (7) and Margate City (7) (Atlantic Co.). *Ocean City (3), Cedar Springs (1), Ocean View (2), Sea Isle Junction (3), Dennisville (4), Sea Isle City (10), Avalon (1), Swainton (1), Bennett (3), and *Cape May (4) (Cape May Co.).

DELAWARE: Newark (5), Glasgow (1) and Delaware City (1) (New Castle Co.). Smyrna (Kent Co.) (2). Ellendale (1), *Rehoboth Beach (1), Gumboro (1), Magnolia (24), Bethany Beach (2) and 2 ms. S. of Bethany Beach (21) (Sussex Co.).

MARYLAND: Jennings, 3000 ft. (Garrett Co.) (4). Mountains 8 ms. S. of Frederick (6) and Urbana (1) (Frederick Co.). Mt. Quirauk to High Rock, Blue Ridge (Frederick-Washington Cos.) (1). Tacoma Park (1), Plummer's Island (10), and Forest Glen (1) (Montgomery Co.). College Park (1), Bowie (1) and Suitland bog (4) (Prince Georges Co.). River View (Anne Arundel Co.) (1). Chesapeake Beach (Calvert Co.) (1). Baltimore Co. (1). Bald Friar (Cecil Co.) (1). *Chestertown (Kent Co.) (4). Costen, 3 ms. NW. of Pocomoke City (Somerset Co.) (3).

DISTRICT OF COLUMBIA: Rock Creek (4) and *Washington (29).

VIRGINIA: Arlington (Arlington Co.) (1). Great Falls (2), Difficult Run (3), Falls Church (3), Clifton (3) and Mt. Vernon (1) (Fairfax Co.). Quantico (Prince William Co.) (1). N. fork of Shenandoah River, E. of Woodstock (Shenandoah Co.) (1). 4 ms. E. of Broadway, 1000 ft. (Rockingham Co.) (1). Vic. of Lignum (2) and Mt. Pony, near Culpeper (4), (Culpeper Co.). Skyline Drive, 10 ms. S. of Rt. 211 (Madison Co.) (1). Hopeville Gap, Bull Run Mts. (1). *Orange (Orange Co.) (5). *Fredericksburg (Spotsylvania Co.) (14). Rappahannock River NE. of Loretto (1) and Tappahannock (3) (Essex Co.). Old Church on Pamunkey River by Newcastle Bridge (Hanover Co.) (7). *Charlottesville (Albemarle Co.) (26). Fossifern, Johnson River, (1), *Hot Springs (8) and Collison Ridge, 2700-3200 ft. (16) (Bath Co.). Covington (Alleghany Co.) (1). ¾ m. SW. of Tye River Gap, Blue Ridge Parkway, 3200 ft. (1) (Nelson Co.) (4). Sweetbriar (Amherst Co.) (3). James River W. of Varina (1) and W. of Elko (1) (Henrico Co.). Below Lake Mataoka, Williamsburg (James City

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[46] It is in many cases impossible to evaluate older records of *lateralis* unless part of the material then reported is before us, or other series from the same locality are available. In consequence it has been necessary to disregard a limited number of records appearing in past literature, particularly those from the broad sweep of territory where *lateralis* is atypical, or where it intergrades with *T. l. cazieri*. Without personal evaluation of material from these areas and on the basis of an arbitrary assignment, such records would confuse, rather than aid, the student. The asterisk before a locality indicates it has been previously published, the number following the locality shows the numerical representation.

Co.) (1). Between Eastville and Cheriton (18) and Birdsnest (33) (Northampton Co.). Harpersville (Warwick Co.) (2). Indian Point, James River (Prince George Co.) (5). Appomattox River 2 ms. W. of Petersburg (1) and *Petersburg (11) (Dinwiddie Co.). *Appomattox (Appomattox Co.) (1). *Lynchburg (Campbell Co.) (1). Blue Ridge Parkway 14 ms. SE. of Snowden, 1875 ft. (1), ditto 8 ms. S. of Snowden, 1375 ft. (1) (Bedford Co.). *Roanoke (Roanoke Co.) (1). Peters Mtn., 3050 ft. (Craig Co.) (1). Mountain Lake (Giles Co.) (27). Blacksburg (Montgomery Co.) (4). Pulaski (Pulaski Co.) (2). 7 ms. NW. of Floyd, 2000 ft. (1), 5 ms. NW. of same, 2300 ft. (1), 3 ms. E. of Willis, 2700 ft. (4), and Blue Ridge Parkway Intersection 6 ms. S. of Floyd, 2800 ft. (14) (Floyd Co.). Along Nottoway River SE. of Stony Creek (2), west of Homeville (8), and along Nottoway River E. of Huske (1) (Sussex Co.). West of Claremont (17), James River W. of Ingersoll (1) (Surrey Co.). Burwells Bay below Rushmore on James River (Isle of Wight Co.) (1). *Cape Henry (Princess Anne Co.) (10). Lake Drummond near Portsmouth Ditch, Dismal Swamp (2), and Hickory (4) (Norfolk Co.). SE. of Cox's Landing (2), E. of Cox's Landing, near Blackwater River (3), Baker Pond, S. of Nurney (3) and Suffolk (1) (Nansemond Co.). NW. of Courtland on Nottoway River (8), 3 ms. S. of Adams Grove, near Meherrin River (1), N. of Little Texas, Meherrin River (1), along Three Creek (1), Womble's Mill Pond, N. of Baffle (1), and Franklin City (5) (Southampton Co.). NW. of Taylor's Mill Pond (1), James River Junction (1), Three Creek, NW. of Emporia (1) and Fontaine Creek, W. of Dahlia (1) (Greensville Co.). South Boston (Halifax Co.) (5). 6 ms. N. of Wytheville (Wythe Co.) (1). Summit of Walker Mts. 3950 ft. (2) (Bland-Wythe Cos.). 4 ms. N. of Chatham Hill on road crossing of Brushy Mtn., 3064 ft. (Smythe-Tazewell Cos.) (1). Cove Creek on Clear Fork, 2350 ft. (2) and Burkes Garden, 3100-3300 ft. (4) (Tazewell Co.). W. side of road crossing of Iron Mtns. N. of Troutdale, 3300 ft. (1), Iron Mts. 6 ms. SE. of Marion, 2900 ft. (1), and 3 ms. E. of Marion, 2300 ft. (1) (Smyth Co.). Elk Gardens, Mt. Rogers, 4400-4800 ft. (Smyth-Grayson Cos.) (2). Clinchfield, 1950 ft. (Russell Co.) (6). 1 m. NW. of Tacoma, 2200 ft. (9) (Wise Co.). E. side of Cumberland Gap, 1350 ft. (Lee Co.) (4).

West Virginia: ¾ ms. SW. of Romney, 600 ft. (Hampshire Co.) (1). Nr. Moorefield (Hardy Co.) (7). "Birthplace of Rivers," 4160 ft. (Pendleton- Pocahontas Cos.) (1). Ellenboro, 780 ft. (Ritchie Co.) (1). Nr. Rock Camp, 1275 ft. (Monroe Co.) (2). Gap in East River Mtn. NW. of Rocky Gap on line of Bland Co., Va. and Mercer Co., W. Va., 3300 ft. (1). Nr. Sulphur, 5 ms. W. of Milton, 600 ft. (Cabell Co.) (1). Nr. Lavalette, 567 ft. (1), and Cabwaylingo State Forest (9) (Wayne Co.).

North Carolina: Point Harbor (Currituck Co.) (5). Camden (Camden Co.) (7). Hertford (Perquimans Co.) (3). *Tunis (Hertford Co.) (4). *Weldon (2), and 2 ms. S. of Weldon on U.S. 301 (2) (Halifax Co.). Chapel Hill (Orange Co.) (3). Burlington (Alamance Co.) (2). *Greensboro (Guilford Co.) (5). Nance (Rockingham Co.) (1). Doughton Park

(Wilkes Co.) (1). Valle Crucis (Watauga Co.) (18). Ingalls (9), *Linville (5), and *Pineola (2) (Avery Co.). Swiss (Yancey Co.) (1). Betw. Lake Tahoma and Buck Creek Gap, 1800 ft. (8), and Mt. Mitchell, 6600 ft. (1) (McDowell Co.). *Asheville (31), and Black Mountains (7), (Buncombe Co.). Crestmont, 1600, 1700, 1800, 2000, 2100, 3000, 4800 and 5600 ft. (42) (Haywood Co.). Buck Spring Gap, Pisgah Ridge, 4950 ft. (Haywood-Transylvania Cos.) (1). Lower Avery Creek, S. slope of Pisgah Ridge, 2200 ft. (1), Cold Mountain Gap, 6.3 ms. from Lake Toxaway (1), and Lake Toxaway, 3200 ft. (1) (Transylvania Co.). Balsam Gap, 3315 ft. (Jackson-Hayward Cos.) (2). Glenville (2), Whiteside Cove, S. base of Whiteside Mtn., Cohee Mts., 2775 ft. (3), Betw. Cashiers and Cowee Gap, 3625 ft. (2), E. side of Cowee Gap, 4150 ft. (2), Balsam (2), 1.8 ms. W. of Dillsboro (1), Cashiers, 3500 ft. (5), Lake Fairfield, 2 ms. E. of Cashiers (2), 2.6 ms. SE. of Cashiers (4), 4.3 ms. SSE. of Cashiers (5), and 6.9 ms. SSE. of Cashiers (1) (Jackson Co.). Great Smoky Mountains, National Park, 5266 ft. (5), Betw. Newfound Gap and Smokemont, Great Smoky Mountains National Park, 2800 ft. (1), Indian Gap, Great Smoky Mountains National Park, 5266 ft. (5), 3-5 ms. SW. of Bryson City (2), and Governor's Island (2) (Swain Co.). 4 ms. E. of Highlands, 2940 ft. (18), slopes along Cullasaja River, 1.5 ms. below Cullasaja Falls, 2100 ft. (2), Wayah Creek (3), Cliffside Recreation Area (3), Franklin (1), 10 ms. S. of Franklin, 1750 ft. (1), 8.9 ms. W. of Franklin (7), Highlands (2), 0.9 ms. N. of Highlands (1), near Upper Ravenel Lake, 4.5 ms. NE. of Highlands, 4150 ft. (1), Short Creek, Cullasaja River, 8 ms. NW. of Highlands, 2800 ft. (3), 3 ms. W. of Highlands, 3950 ft. (1), 4.2 ms. SW. of Highlands (2), 7 ms. SW. of Highlands (3), along U.S. 62, ¾ m. above Shortoff Church, 3.5 ms. from Highlands, 4080 ft. (1), and 4.7 ms. S. of Highlands (2) (Macon Co.). Lake Santeelah, 1500 ft. (17), and betw. Tipton and Robbinsville, 2800 ft. (5), (Graham Co.). Glade Gap, 3673 ft. (1) (Clay Co.). Summit of Fayne's Mtn. (2), and U.S. 64 at 2.2 ms. W. of Murphy, 1500 ft. (1) (Cherokee Co.). Hendersonville (5), and near Fletcher, 2050 ft. (1) (Henderson Co.). *Mt. Pisgah, 4500 ft. (5), and Pisgah National Forest (1) (Alexander Co.). Salisbury (Rowan Co. (3). *Raleigh (Wake Co.) (22). *Selma (Johnston Co.) (3). Goldsboro (Wayne Co.) (12). Roanoke Island (5), and Kitty Hawk (1), (Dare Co.). *New Berne (Craven Co.) (2). New River (Onslow Co.) (1). Near Rose Hill (2), and Wallace (1), (Duplin Co.). Holly Shelter Refuge, 13 ms. E. of Burgaw (Pender Co.) (1). *Southport (Brunswick Co.) (1). *Lake Waccamaw (Columbus Co.) (56). *Fayetteville (Cumberland Co.) (6). Stedman Fish Hatchery (Hoke Co.) (1). Southern Pines (Moore Co.) (5). *Charlotte (Mecklenburg Co.) (3). *Morganton (Burke Co.) (2). *Wrightsville (3), *Wilmington (3), and *Winter Park (3) (New Hanover Co.).

South Carolina: CCC Camp F2 (Oconee Co.) (3). Along Rocky Bottom, 1600 ft. (2) (Pickens Co.). *Spartanburg (Spartanburg Co.) (1). Myrtle Beach (Horry Co.) (5). *Florence (Florence Co.) (4). Sumter (Sumter Co.) (1). *Columbia (Richland Co.) (2). *Manning (6), and St.

Paul (1) (Clarendon Co.). Lane (Williamsburg Co.) (1). *Denmark (Bamberg Co.) (1). *N. end of Sullivan Island (2), Seven Mile (3), and *Ashley Junction (2) (Charleston Co.). *Yemassee (Hampton Co.) (16). Nr. Switzerland (Jasper Co.) (1). 1 m. N. of Limehouse (Beaufort Co.) (3).

Georgia: *Sand Mtn. near Trenton (11), and *Trenton (2) (Dade Co.). Neel Gap (2), and 5 ms. N. of Blairville, 1900 ft. (1) (Union Co.). Mountain City (7), George Mtn., Dillard, 2400-2800 ft. (5), *Clayton (2), Rabun Bald, 4600-4717 ft. (1), Chestnut Ridge, Rabun Bald, 4000 ft. (1), Raven Rock Mtn., 3000-3200 ft. (1), and Scaly (3) (Rabun Co.). 19 ms. N. of Dahlonega (2), and 21 ms. N. of Dahlonega (1) (Lumpkin Co.). Gainesville (2), and White Sulphur Springs (3) (Hall Co.). Thomas (Floyd Co.) (10). Athens (1) (Clarke Co.) (5). *Atlanta (Fulton Co.) (8). *Vic. of Stone Mtn. (De Kalb Co.) (12). *Thomson's Mills (McDuffie Co.) (2). Cedar Rocks, 5 ms. N. of Jackson (Butts Co.) (1). *Macon (59), and Holten (1) (Bibb Co.). Louisville (Jefferson Co.) (2). *Augusta (Richmond Co.) (1). Dublin (Laurens Co.) (1). Leslie (Sumter Co.) (1). Vidalia (Toombs Co.) (1). Groveland (Bryan Co.) (1). 5 ms. S. of Riceboro (Liberty Co.) (1). *Savannah (Chatham Co.) (1). *Albany (Dougherty Co.) (6). 2.5 ms. S. of Alma, (Bacon Co.) (1). *Jesup (10), and 1.8 ms. N. of Screven (Wayne Co.) (1). Cox (3), and 3 ms. N. of Darien (2) (McIntosh Co.). 10.8 ms. E. of Leary (Calhoun Co.) (3). Tifton (Tift Co.) (1). DeWitt (Mitchell Co.) (1). *Hebardville (3), Okeefenokee Swamp (4), and *Waycross (3) (Ware Co.). Okeefenokee Swamp (Charlton Co.) (7). *Brunswick (Glynn Co.) (6). 1 m. W. of Stockton (Lanier Co.) (1). Roy's Lake (3), Sealey's Spring (35), and 2 ms. E. of Swinging Bridge (3) (Seminole Co.). *Bainbridge (16), and *Spring Creek (7) (Decatur Co.). *Thomasville (73), and *Ocklockonee River (2) (Thomas Co.). *Homerville (Clinch Co.) (15). 2.3 ms. N. of Kingsland (Camden Co.) (1). Billy's Island, Okeefenokee Swamp (12). *Mixon's Hammock, Okeefenokee Swamp (8).

Florida: Pensacola (3), and *Fort Barrancas (5) (Escambia Co.). Crestview (Okaloosa Co.) (2). De Funiak Springs (7) and 9.4 ms. E. of De Funiak Springs (7) (Walton Co.). Bonifay (Holmes Co.) (1). ½ m. S. of Ebro (Washington Co.) (1). 2 ms. W. of Franklin Co. line, (Gulf Co.) (1). Campbellton (1), Grand Ridge (2), *Marianna (6), 2 ms. NE. of Marianna (3), and Taylor's Pond (7) (Jackson Co.). Chipola River (1), Blountstown (1), and 6 ms. S. of Blountstown (13) (Calhoun Co.). Camp Torreya (38), Rock Bluff Landing (11), Torreya State Park (2), 4.9 ms. S. of junction of Fla. 20 and 67 highways (1), and 3 ms. W. of Hosford (1) (Liberty Co.). Carrabelle (3), and 2 ms. W. of Apalachicola (1) (Franklin Co.). River Junction (17), Midway (1), Chattahoochee (1), 1.1 ms. W. of Gretna (1), and Quincy (1) (Gadsden Co.). Woodville (2), *Tallahassee (1), 2 ms. W. of Tallahassee (1), and 7.1 ms. E. of Ochlockonee River (3) (Leon Co. (7)). Wakulla Springs (Wakulla Co.) (12). Lake Miccosuckee (8), *Monticello (12), and Waukeenah (9) (Jefferson Co.). Greenville (Madison Co.) (4). 7 ms. NW. of Perry (Taylor Co.) (1).

Houston (2), Wellborn (4), and *Live Oak (1) (Suwannee Co.). *Lake City (3), (Columbia Co.) (33). *Atlantic Beach (1), *Pablo Beach (11), and *Jacksonville (13) (Duval Co.). Anastasia Island, St. Augustine (St. Johns Co.) (4). Green Cove Springs (Clay Co.) (1). *Gainesville (380), 4 ms. S. of Gainesville (1), 6 ms. W. of Gainesville (3), 1.8 ms. E. of Gainesville (3), 6 ms. NE. of Gainesville (3), Payne's Prairie (3), Fairbanks (2), San Felasco Hammock (5), ½ m. N. of Paradise (5), Hague (5), Rochelle (1), Poe Spring (6), High Springs (9), Trenton (2), Newman's Lake (29), 6 ms. W. of Newman's Lake (4), Levy-Warburg Lake (18), Waldo (36), and 3.5 ms. N. of Waldo (3) (Alachua Co.) (109). Cross City (Dixie Co.) (5). 5 ms. N. of Sumner (24), Sumner (1), Waccasassa River (2), Cedar Keys (4), Gulf Hammock (5), Lebanon Station (1), and Otter Creek (4) (Levy Co.). Ocala National Forest (31), Ocala (2), Dunnellon (1), 4 ms. NW. of Dunnellon (1), Micanopy (10), and 3 ms. SW. of Micanopy (1) (Marion Co.). Welaka (144), Pomona (2), and Crescent City (2) (Putnam Co. (9)). Marineland (Flager Co.) (1). 1.5 ms. E. of Glenwood (1), De Leon Springs (2), *Sanford (3), and Ormond (2) (Volusia Co.). 1.75 ms. E. of Lisbon (1), 1.5 ms. W. of Astor (1), 7/10 m. N. of Pittman (3), 2 ms. W. of Tavares (1), Leesburg (1), 1 m. N. of Leesburg (1), Astatula (8), and 2.5 ms. W. of Crow's Bluff (1) (Lake Co.). 4.6 ms. W. of Bushnell (Sumter Co.) (1). 4 ms. E. of Inverness (Citrus Co.) (7). Betw. Masaryktown and Brooksville (Hernando Co.) (3). Fort Reed (2), Orlando (4), Winter Park (1), Taft (1), and Apopka (2) (Orange Co.). Kissimmee (10), 3 ms. W. of Kissimmee (1), 4 ms. S. of Holopaw (1), and Lokosee (5) (Osceola Co.). Lake Streaty (1), Auburndale (6), and Lakeland (18) (Polk Co.). Lacoochee (2), Trilby (2), Hudson (1), and 9 ms. NE. of New Port Richey (2) (Pasco Co.). Little Manatee River (1), Plant City (1), near Tampa (1), and betw. Oldsmar and Tampa (11) (Hillsborough Co.). Dunedin (33), 2 ms. N. of Tarpon Springs (1), 2.4 ms. E. of Tarpon Springs (1), Gulfport (1), Walls Springs (1), and Anona (1) (Pinellas Co.). Vero Beach (Indian River Co.) (2). Manatee (10), Oneco (6), and Parish (1) (Manatee Co.). Lake Placid (Highlands Co.) (3). Okeechobee (Okeechobee Co.) (2). Fort Pierce (5), White City (1), and *Viking [old Capron] (1) (St. Lucie Co.). Gardener (1), Placida (2), Arcadia (4), and Fort Ogden (2) (De Soto Co.). 3 ms. E. of Sarasota (8), Myakka River State Park (17), and 6 ms. NW. of Murdock (1) (Sarasota Co.). *Punta Gorda (5) (Charlotte Co.). 2 ms. W. of Ortona (10), Palmdale (1), and 5 ms. SE. of Palmdale (1) (Glades Co.). Lake Okeechobee (2), Belle Glade (1), and South Bay (1) (Palm Beach Co.). LaBelle (Hendry Co.) (5). *Fort Myers (27), 3 ms. SW. of Estero (1), and Bonita Springs (12) (Lee Co.). 4.2 ms. S. of Lee-Collier Co. line (2), 3 ms. SE. of Naples (1), 12 ms. S. of Naples (1), Collier Seminole State Park (1), and Ochopee, 10 ms. NE. of *Everglades (2) (Collier Co.). Fort Lauderdale (27), Davie (1), and Deerfield (2), (Broward Co.). Little River (2), Cutler (1), Homestead (20), Timm's Hammock (1), Miami (6), and Headquarters Everglades Nat. Park (1) (Dade Co.). Paradise Key (Monroe Co.) (13).

Illinois: *White Heath (Piatt Co.) (4). *Oakwood (2), and *Muncie (2) (Vermilion Co.). *Odin (Marion Co.) (1). East St. Louis (St. Clair Co.) (2). Carbondale (Jackson Co.) (1). Anna (1) (Union Co. (2)). Tunnel Hill (1), and Glen Fern (31) (Johnson Co.). Pulaski Co. (19). Golconda (Pope Co.) (1). *Metropolis (Massac Co.) (1).

Indiana: Davis Woods (La Porte Co.) (4). Kosciusko Co. (4). Vermillion Co. (1). *Vigo Co. (14). Marion Co. (84). Vincennes (1) (Knox Co. (1)). *Posey Co. (2). Brown Co. (1). Bloomington (7), near Scott's Pond, Bloomington (2), and 5 ms. N. of Bloomington (8), (Monroe Co.). Wickcliffe (Crawford Co.) (1). Hanover (8) (Jefferson Co. (2)). Smith Station (9). Sheffield (1).

Ohio: Williams Co. (1). Defiance Twp., Defiance Co. (9). Mendon, Mercer Co. (26). Cedar Swamp (Champaign Co.) (26). Washington Twp., (Anglaize Co.) (1). Hale Twp. (6), and McDonaldson Twp. (1) (Hardin Co.). Marion (1), Marion Twp. (1), and Scott Twp. (2) (Marion Co.). Franklin Twp. (Morrow Co.) (1). Delaware (1), and Marlboro Twp. (3) (Delaware Co.). Holmesville (Holmes Co.) (1). Wayne Twp. (1), Meigs Twp. (2), and Duncan Falls (1) (Muskingum Co.). Belpre (Washington Co.) (4). *Columbus (48), and Blacklick Woods (3) (Franklin Co.). Reading Twp. (2), Thorn Twp. (2), and Madison Twp. (1), (Perry Co. (2)). Harrison Twp. (6), Buckeye Lake (4), and Burlington Twp. (1) (Licking Co.). Cavallo (Coshocton Co.) (8). Camp Clifton (Greene Co.) (1). Violet Twp. (24), Berne Twp. (3), Kettle Hill (2), and Greenfield Twp. (7) (Fairfield Co.). *Sugar Grove (2), Old Man's Cave (2), Good Hope Twp. (1), Cedar Falls (1), "Neotoma" (22), Neotoma River (1), Benton Twp. (1), Laurel Twp. (1), and Salt Creek Twp. (2) (Hocking Co.). Derby (12), Jackson Twp. (1), Circleville (2), and Renick's Bog (1) (Pickaway Co.). Jackson Twp. (1), Mifflin Twp. (1), and Benton Twp. (1), (Pike Co.). Bristol (1), and Malta (1) (Morgan Co.). Athens (Athens Co.) (4). Rock River (5), Liberty Twp. (1), Washington Twp. (6), and Byers (1) (Jackson Co.). Reilly Twp. (Butler Co.) (5). Madison Twp. (1), and Wayne Twp. (8) (Fayette Co.). Fort Hill (12), and Brush Creek Twp. (9), (Highland Co.). Gallia (Gallia Co.) (10). Salem Twp. (Meigs Co.) (2). Locust Grove (3), Franklin Twp. (4), Beaver Pond (1), 6 ms. S. of Mason (1), and Oliver Twp. (1) (Adams Co.). Fort Ancient (Warren Co.) (2). Union Twp. (Clermont Co.) (2). Kingston (Ross Co.) (1).

Kentucky: 2 ms. NE. of Fairview (Fleming Co.) (1). Berea (Madison Co.) (1). Bee Spring (Edmonson Co.) (3). Guthrie (Todd Co.) (1). Osceola to Greensburg (Green Co.) (1). Nr. Jellicoe Creek, 958 ft. (McCreary Co.) (1). Betw. Lamero and Mershons, 1250 ft. (Laurel Co.) (2). Wofford, 800 ft. (Whitley Co.) (1). Nr. Molus, 1100 ft. (Harlan Co.) (1). Ermine, 1180 ft. (Letcher Co.) (4). 3 ms. S. of Wasioto, 1050 ft. (13), and Pineville (1) (Bell Co.). Lawrence (1).

Tennessee: Cedar Creek (Campbell Co.) (2). Oneida (1), and 2 ms. W. of Rugby Road, 1450 ft. (1) (Scott Co.). Allardt, 1300-1650 ft. (152),

and Ben-Stockton (1) (Fentress Co.). Antioch (Trousdale Co.) (7). 2 ms. SE. of Hendersonville (Sumner Co.) (1). *Clarksville (Montgomery Co.) (78). Reelfoot Lake (Obion Co.) (3). Camden (Benton Co.) (2). Danville (Houston Co.) (1). 4 ms. W. of Dickson (Dickson Co.). (1). 3.2 ms. N. of Franklin (3), 1.3 ms. E. of Nolensville (3), and 2.4 ms. E. of Nolensville (3), (Williamson Co.). 1 m. SE. of Goodlettsville (1), 2 ms. SW. of Nashville (7), Nashville (12), 13 ms. SE. of Nashville (1), 4.2 ms. S. of Scottsboro (10), 4.5 ms. SE. of Antioch (1), and Radnor Lake (1) (Davidson Co.). Baxter (Putnam Co.) (2). Grassy Cove, 1600-2000 ft. (77), and Crab Orchard (7) (Cumberland Co.). Clear Fork, near Burrville (Morgan Co.) (2). Between Norris Dam and Norris, 650 ft. (Anderson Co.) (3). *Morristown (Hamblen Co.) (1). Frank's Creek (Greene Co.) (1). *Johnson City (Washington Co.) (3). Roan Mtn. 2600-3000 ft. (8), and *Roan Mtn. Station (3) (Carter Co.). Hartford (Cocke Co.) (6). Chilhowee Mtn. (9), Clingman's Dome, 6300-6642 ft. (8), Gatlinburg (6), Linesprings to *Elkmont, 2500 ft. (1), and 10 ms. W. of Sevierville (1) (Sevier Co.). *Knoxville (45), and University of Tennessee Farm (43) (Knox Co.). W. side of Deal's Gap (3), and Cades Cove (2) (Blount Co.). Betw. Madisonville and Gudger (Monroe Co.) (2). Sparta (White Co.) (1). McMinnville (Warren Co.) (5). 5.2 ms. E. of Shelbyville (9). 6 ms. E. of Shelbyville (3), and 3 ms. E. of Longview (13) (Bedford Co.). 5.7 ms. W. of Columbia (15), and 2.8 ms. SE. of Mt. Pleasant (9) (Maury Co.). Jackson (Madison Co.) (5). 3 ms. S. of Ripley (Lauderdale Co.) (3). Memphis (Shelby Co.) (4). 3 ms. E. of Bolivar (4), and Whiteville (1) (Hardeman Co.). 13 ms. W. of Lawrenceburg (Lawrence Co.) (1). 3.1 ms. W. of Pulaski (3), 9 ms. W. of Pulaski (1), 5 ms. E. of Pulaski (1), and 4.3 ms. W. of Frankewing (6) (Giles Co.). 1.4 ms. E. of Mulberry (1), 3.4 ms. S. of Mulberry (2), and Fayetteville (1) (Lincoln Co.). Near Hale's Bar Dam, 600 ft. (Marion Co.) (1). *Chattanooga (Hamilton Co.) (7). Chimney Camp (1), The Loop (9) and Green Briar Cove (1) (Great Smoky Mountains National Park).

Alabama: Margerum, 400 ft. (Colbert Co.) (10). 1 m. W. of Greenbrier (12), and Veto (1) (Limestone Co.). *Valley Head (2), and *Lookout Mtn. at Valley Head (3) (De Kalb Co.). Squaw Shoals, Black Warrior River (Jefferson Co.) (1). 1.5 ms. S. of Oxford (Calhoun Co.) (7). Cheaha Mtn., 2200 ft. (Cleburne Co.) (7). *Tuscaloosa (Tuscaloosa Co.) (2). Boligee (Greene Co.) (5). Opelika (1), Auburn (27), and Sougahatchee Creek (1) (Lee Co.). Selma (Dallas Co.) (14). *Greenville Butler Co.) (4). 2.8 ms. W. of Alabama River at Claiborne (Monroe Co.) (1). Evergreen (23), 1.1 and 1.7 ms. S. of Dothan (1), and Chattahoochie State Park (8) (Houston Co.). *Flomaton (Escambia Co.) (9). Mobile (15), Irvington (16), and St. Elmo (1) (Mobile Co.). Mobile Bay (Baldwin Co.) (2). De Soto State Park (1).

Mississippi: Iuka (1), and Burnsville, 475 ft. (6) (Tishomingo Co.). 12 ms. E. of Mathiston (Oktibbaha Co.) (8). Greenville (Washington Co.) (3). Vicksburg (Warren Co.) (1). Jackson (Hinds Co.) (10). Strickton

(Rankin Co.) (15). Forest, 450 ft. (Scott Co.) (9). Meridian (Lauderdale Co.) (1). Brookhaven (Lincoln Co.) (4). *Hattiesburg (Forrest Co.) (7). Pass Christian (5) Biloxi (6), Ship Island (1), and Handsboro (3) (Harrison Co.).

LOUISIANA: Shreveport (Caddo Parish) (5). Gibsland (2), and Arcadia (1) (Bienville Parish). West Monroe (Ouachita Parish) (22). Delta (5) and Mound (1) (Madison Parish). Winnfield (Winn Parish) (3). Alexandria (Rapides Parish) (12). 3.1 ms. N. of Merryville (Beauregard Parish) (2). Eunice (1), and *Opelousas (21) (St. Landry Parish). Baton Rouge (5), and Greenwell Springs (1) (East Baton Rouge Parish). Breckenridge (Livingston Parish) (28). Slidell (3), and Mandeville (4) (St. Tammany Parish). Lake Charles (7), and Holmwood (1) (Calcasieu Parish). Lafayette (Lafayette Parish) (15). New Orleans (23), Orleans Canal nr. Spanish Fort (1), Spanish Fort (11), and Milneburg (4) (Orleans Parish). St. Rose (St. Charles Parish). Harahan (Jefferson Parish) (3). Buras (Plaquemines Parish) (1). Rhoda (1), and Morgan City (37) (St. Mary Parish). 13 ms. E. of Creole (Cameron Parish) (2).

IOWA: Marion Co. (1). Keokuk Co. (1). *Van Buren Co. (1).

MISSOURI: *Atherton (Jackson Co.) (13). Columbia (Boone Co.) (1). St. Charles (St. Charles Co.) (1). Kirkwood (St. Louis Co.) (2). Willard (29), and Springfield (1) (Greene Co.). Hollister (Taney Co.) (2).

ARKANSAS: *Fayetteville (1), and *Winslow (6) (Washington Co.). *Rich Mtn. Station (12), *Rich Mtn. Summit, 2000 ft. (2), *Eagleton (1), and *Mena (5) (Polk Co.). *De Queen (Sevier Co.) (13). *Ashdown (Little River Co.) (14). *Magazine Mtn., 2600 ft. (Logan Co.) (3). *Dardanelle (2), and *Ola (4) (Yell Co.). 4 ms. SW. of Mountain View, 1100 ft. (Stone Co.) (4). 3 ms. S. of Batesville, Independence Co. (3). Imboden (Lawrence Co.) (2). 7 ms. E. of Augusta, 200 ft. (Woodruff Co.) (1). 6 ms. E. of Fair Oaks, 225 ft. (Cross Co.) (19).

KANSAS: *Coffey Co. (2). *Montgomery Co. 798 ft. (2).

OKLAHOMA: Stringtown (Atoka Co.) (1). Mayes Co. (2). Wyandotte (3) (Ottawa Co. (1)). Bluejacket (Craig Co.) (2). Grove (1), and Flint (3) (Delaware Co.). Sequoyah Co. (7). *Howe (La Flore Co.) (12). *Wilburton (Latimer Co.) (12). 6.5 ms. NE. of Idabel (8), Idabel (1), 6 ms. SW. of Eagletown (1), and Broken Bow (2) (McCurtain Co.).

TEXAS: San Antonio (6), and Salado Creek, Fort Sam Houston (2) (Bexar Co.). Kingsville (Kleberg Co.) (2). Austin (Travis Co.) (9). San Marcos (Hays Co.) (1). 6 ms. N. of New Braunfels (Guadelupe Co.) (3). Palmetto State Park, Luling (Caldwell Co.) (4). Victoria (Victoria Co.) (2). Flatonia, 475 ft. (Fayette Co.) (1). *Paige (Bastrop Co.) (7). Colorado Co. (4). Navasota (Grimes Co.) (3). *College Station (9) (Brazos Co.) (2). Hearne (Robertson Co.) (1). Rosenberg (Fort Bend Co.) (1). 1.9 ms. E. of Trinity River on U.S. 190 (Polk Co.) (6). 9.3 ms. W. of Woodville on U.S. 190 (Tyler Co.) (4). *Houston (12), Crosby (2), Harrisburg (1), and Webster (1) (Harris Co.). 29 ms. NE. of Houston on U.S. 90 (1). Dickinson (Galveston Co.) (2). Beaumont (Jefferson Co.) (18).

Liberty Co. (5). Day Ranch, Cedar Hill (Dallas Co.) (1). Elkhorn (Anderson Co.) (2). Tyler (3) (Smith Co. (1)). Longview (Gregg Co.) (1). Wolfe City (Hunt Co.) (1). Avery (Red River Co.) (15). Paris (Lamar Co.) (3). Harrison Co. (1).

## Atypical *T. lateralis lateralis*

ONTARIO: Vineland (1), Ridgeway (1), Mer Bleu (5), Turkey Point (5), Strathroy (1), *Kingsville (1), *Wheatley (3), Leamington (1), and *Point Pelee (11).

QUEBEC: Hemmingford (1).

MAINE: Lincoln Co. (1).

VERMONT: Hartland (1) and Woodstock (3) (Windsor Co.).

NEW HAMPSHIRE: 5 ms. S. of Hinsdale (Cheshire Co.) (1).

MASSACHUSETTS: *Winchedon (Worcester Co.) (2). *Wellesley (Norfolk Co.) (2).

RHODE ISLAND: Wesquage Beach (Washington Co.) (2). *Block Island (Newport Co.) (2).

CONNECTICUT: South Meriden (New Haven Co.) (2).

NEW YORK: Saranac Lake (Franklin Co.) (2). *Summit of White Face Mountain, 4800 ft. (Essex Co.) (2). Lake George (1). Chaffee (Erie Co.) (1). *Ithaca (34), *McLean (5), and Ringwood (1) (Tompkins Co.). Mahopac Falls (Putnam Co.) (1). Mosholu (Westchester Co.) (1). *West Point (Orange Co.) (2). Vicinity of New York City (1). Brooklyn (Kings Co.) (1). Cold Springs Harbor (3), and *Montauk (Suffolk Co.) (1). Staten Island (3), and *St. George, Staten Island (1) (Richmond Co.).

PENNSYLVANIA: Presque Isle (Erie Co) (1). Butler (Butler Co.) (1). Schenley (Allegheny Co.) (1). Beatty (Westmoreland Co.) (5). Johnstown (Cambria Co.) (2). Tyrone (Blair Co.) (1). Diamond Valley (Huntingdon Co.) (13). Betw. Bald Eagle and Hannah (Centre Co.) (4). Harvey's Lake (Luzerne Co.) (1). Panther, 2150 ft. (9) and Panther Hills, Panther, 2200-2500 ft. (6) (Pike Co.). Betw. Mountain Home and Laanna, 1350 ft. (Monroe Co.) (1). Cole Creek Notch (Columbia Co.) (1). Walnut Grove School, 1m. SW. of Abbottstown (Adams Co.) (8). York (1) and Washington Township (1) (York Co.). Hummelstown (3) and Harrisburg (2) (Dauphin Co.). 3 ms. E. of Vinemont, 750 ft. (Berks Co.) (1). Valley Forge (4), Sylmar (2), Northbrook (1) and Malvern (1) (Chester Co.). Hill Church (1) and Langhorne (1) (Bucks Co.). Gwynedd (35), Collegeville (3), Edge Hill (4), Fort Washington (2), Ashbourne (4), and Villa Nova (7) (Montgomery Co.). Lawndale (4), Chestnut Hill (14), Mt. Airy (2), Germantown (1), Wyoming (1), and *Philadelphia (13) (Philadelphia Co.). Tinicum (8), *Castle Rock (2), Radnor (1), and Serpentine barrens, Pink Hill, Newton Square (13) (Delaware Co.).

NEW JERSEY: Old Tappan (Bergen Co.) (2). South Orange (Essex Co.) (1). *Prospertown (1), Point Pleasant (1), *Ortley (1), Spray Beach (1), *Stafford's Forge (5), and West Creek (1) (Ocean Co.). Taunton (1), and *Riverton (3) (Burlington Co.).

West Virginia: Salem (Harrison Co.) (1). 4 ms. E. of Elkins, 2300 ft. (1), 5 ms. E. of Elkins, 2600 ft. (1), and slopes above road crossing of Dry Fork River, SW. of Harman, 3000 ft. (2) (Randolph Co.). Road crossing of Fore Knobs Mountain, 2721 ft. (Mineral Co.) (2). Spruce Knob, 4600 ft. (2), and 1 m. S. of Mouth of Seneca (1) (Pendleton Co.). Nr. Bluefields, 2800 ft. (Monroe Co.) (1).

Michigan: Wexford Co. (1). Iosco Co. (1). Gladwin Co. (1). Midland (Midland Co.) (4). Bay Co. (5). Sand Point (11) (Huron Co. (5)). Muskegon State Park (Muskegon Co.) (1). Gratiot Co. (1). St. Clair Co. (1). Marine City (8) (St. Clair Co. (1)). Doster (Barry Co.) (1). Aurelius (1), Lansing (21) and Michigan Agricultural College (15) (Ingham Co.). Sayles Lake (1), Strawberry Lake (1), Zukey Lake (3), Iosco Twp. (1), Portage Lake (2), Green Oak Twp. (2), 1.5 ms. N. of White Twin Tower (1), and *E. S. George Reserve (315) (Livingston Co.). Rochester (1), Milford (19), Kent Lake (1), Highlands (1) and Franklin (1) (Oakland Co.). Utica (2) (Macomb Co. (1)). Van Auken Lake (1), and South Haven (10) (Van Buren Co.). Kalamazoo (Kalamazoo Co.) (2). Francisco (8) and Irish Hills (3) (Jackson Co.). Ann Arbor (34), Pittsfield, Ann Arbor (11), Boulevard Marsh, Ann Arbor (1), First Sister Lake, Ann Arbor (5), Third Sister Lake, Ann Arbor (1), White's Woods, Ann Arbor (9), Forestry Farm, Ann Arbor (3), Fiegel's Woods, Ann Arbor (4), Forter, Ann Arbor (1), Barton Pond, Ann Arbor (1), Steere's Swamp, Ann Arbor (16), Third Woods, Ann Arbor (44), 1 m. W. of Ann Arbor (2), Doyle Lake, North Marsh (2), Cavanagh Lake, East Marsh (7), Mill Lake, South Marsh (2), Cavanagh Lake (2), Scioto Twp. (3), Mud Lake (1), Sharon Twp. (5), Sylvan Road (1), Crooked Lake, Sylvan Twp. (1), Freedom Twp. (1), Salem Twp. (4), and Pittsfield Twp. (1) (Washtenaw Co. (8)). Detroit (1) and Northville (12), (Wayne Co. (4)). *Sawyer Dunes, E. K. Warren Preserve (6), *Warren Woods, E. K. Warren Preserve (11), *New Buffalo (3), and Lakeside (4) (Berrien Co.). Klinger Lake (1) and Constantine (1) (St. Joseph Co.). Branch Co. (1). 13.5 ms. E. of Hillsdale (Hillsdale Co.) (1).

Illinois: Wauconda (Lake Co.) (2). *Riverside (16), Evanston (1), *Chicago (42), and *Summit (11) (Cook Co.). *Glen Ellyn (2), and West Chicago (1) (Du Page Co.) Moline (Rock Island Co.) (1). *Havana (Mason Co.) (2). Meredosia (Morgan Co.) (1). *Bloomington (McLean Co.) (4). *Homer (4), and *Urbana (12) (Champaign Co.).

Indiana: Dune Park (36), Lake Station (1), and Millers (2) (Lake Co.). Chesterton (Porter Co.) (3). Kewanna (Fulton Co.) (1). Turkey River State Park (Parke Co.) (1). Muncy (Delaware Co.) (4). Fortville (Hancock Co.) (1).

Ohio: Florence Twp. (1), Northwest Twp. (2), and Mud Lake (2) (Williams Co.). Fulton Co. (4). Crane Twp. (Paulding Co.) (16). Sylvania (2), Dorr and Crescy Roads (9), 6 ms. W. of Toledo (10), Holland (1), Cedar Point (5), Monclova Twp. (1), Spencer Twp. (2), and Swanton Twp. (2) (Lucas Co.). Sandusky Bay (7), 1.5 ms. S. of Lakeside (1), Put-

in-Bay (1), and South Bass Island (1) (Ottawa Co.). Green Springs (Sandusky Co.) (1). Richmond (2) (Huron Co. (1)). Kelly's Island (1), and Castalia (2) (Erie Co.). Amherst Twp. (Lorain Co.) (2). Whipps Ledges, Hinckley Twp. (Medina Co.) (1). Little Mountain (Lake Co.) (1). Ira (Summit Co.) (1). Bainbridge (Geauga Co.) (3). Conneaut (3), Fobes Road, Morgan Twp. (2), and Trumbull Twp. (4) (Ashtabula Co.). York Twp. (Van Wert Co.) (1). Richland Twp. (Allin Co.) (2). Silver Lake (Miami Co.) (1). Champaign Co. (8). Montgomery Twp. (Marion Co.) (1). Indian Lake (1), and Perry Twp. (2) (Logan Co.). High Banks, Metropolitan Park (4), and Orange Twp. (2) (Delaware Co.). Richland Twp. (Holmes Co.) (1). Knox Co. (1). Zanesville (3), and Adamsville (1) (Muskingum Co.). Wheatland Twp. (Guernsey Co.) (3). Summerfield (Noble Co.) (10). Warren Twp. (Washington Co.) (2). Madison Twp. (Montgomery Co.) (3). Spring Valley (Greene Co.) (5). Buzzards Roost Rock (1), Dublin (1), Red Hills (6), S.W. Norwich Twp. (3), Perry Twp. (1), Alum Creek, Columbus (2), Clinton Twp. (2), Indian Run (2), Flatrocks (1), and S.W. Brown Twp. (1) (Adams Co.). Dunn Prairie (Madison Co.) (1). Licking Co. (33). White Eyes Twp. (3), and Bedford Twp. (2) (Coshocton Co.). Crystal Springs (Fairfield Co.) (2). Flatrocks (Lancaster Co.) (19). Bainbridge (24), Colerain Twp. (1), and Liberty Twp. (3) (Ross Co.). Lake Lorain (5). Mt. Logan (1).

Wisconsin: Cranmoor (Wood Co.) (1). Birnamwood (Shawano Co.) (1). Mountain (Oconto Co.) (1). Wilson's Island, Lake Puckaway near Montello (Marquette Co.) (15). Madison (8) (Dane Co. (1)). Milwaukee (Milwaukee Co.) (2).

Minnesota: Battle Creek (1) and St. Paul (Ramsey Co.) (6). La Crescent (Houston Co.) (1).

Iowa: Jones Co. (1). Jackson Co. (1). Iowa City (10) (*Johnson Co. (2)). *Muscatine Co. (1). *Louisa Co. (3). What Cheer (Keokuk Co.) (1). *Jefferson Co. (1). Mt. Pleasant (10) (*Henry Co. (23)). *Des Moines Co. (2). Madison (1) (*Lee Co. (1)).

Missouri: Platte Co. (2).

Kansas: Manhattan (13) (*Riley Co (6)). Wakarusa River (1) (*Douglas Co. (18)).

Oklahoma: Johnston Co. (1). Sallisaw (Sequoyah Co.) (1). Spiro (Le Flore Co.) (2). Tuskahoma (1), and Clayton Lake Park, 5 ms. S. of Clayton (17) (Pushmataha Co.). Betw. Hugo and Grant (Choctaw Co.) (1). *Caddo (Bryan Co.) (1). *Haileyville (4), and [*South] McAlester (4) (Pittsburg Co.). Glover (McCurtain Co.) (6).

Texas: Vance (Real Co.) (5). Beaver Creek and Llano River (Mason Co.) (1). Llano (along Llano River) (Llano Co.) (1). 9 ms. N. of Kerrville (Kerr Co.) (10). Brownwood (Brown Co.) (1). Along Big Sandy (2) (Eastland Co. (3)). Comfort (1), and 3 ms. S. of Kendalia (Kendall Co.) (11). Cotulla (LaSalle Co.) (7). Gainesville (Cooke Co.) (2). Lake Worth (2) (Tarrant Co. (4)). *Denison (Grayson Co.) (2). White Rock Lake (2), and Dallas (9) (Dallas Co.). Waxahatchie (3) (Ellis Co. (1)).

## Intermediate between *T. lateralis lateralis* and *T. l. cazieri*

MANITOBA: Winnipeg (1). Reynolds (8).

ONTARIO: *De Grassi Point, Lake Simcoe (75). *Toronto (5). Black Creek, Toronto (1). Kew Beach, Toronto (2). High Park, Toronto (2). *Owen Sound (1). *North Bay (3). *Ottawa (3). Bolton (1). Osgoode (1). Spencerville (1). Minette (3). Marmora (3). Grimsby (1). Sudbury (1). Bell's Corner (12). Eglington (2). Lefroy (1). Miner's Bay (1). York Mills (1). Medford (2). Detongue Portage (1).

QUEBEC: Chateau Richer (1). St. Jean (1). *St. Hiliare (1). Lac St. Marie (7). Knowlton (8). Knowlton's Landing (1). *Montreal (3). *Lanoraie (1). Fort Coulonge (1). Lachute (1). Aylmer (1). Gracefield (3). Quyon (1). Beech Grove (1). Como (1).

NOVA SCOTIA: South Milford (1).

MAINE: *Orono (Penobscot Co.) (1). Augusta (Kennebec Co.) (1). Norway (4), and *Fryeburg (19) (Oxford Co.). Lewistown (Androscoggin Co.) (1). Kezar Falls (York Co.) (1).

NEW HAMPSHIRE: Warren (1), Bethlehem (1), *Hanover (19), and Franconia (1) (Grafton Co.). Mt. Washington (Coos Co.) (2). Center Harbor (Belknap Co.) (1). Jaffrey (Cheshire Co.) (1).

VERMONT: *Newport (Orleans Co.) (3).

MASSACHUSETTS: Mt. Toby, Franklin Co. (2). Tyngsboro (1) and Sherborn (2) (Middlesex Co.). *Amherst (Hampshire Co.) (4). Forest Hills (Suffolk Co.) (1).

CONNECTICUT: *Canaan (Litchfield Co.) (1).

NEW YORK: Peru (Clinton Co.) (1).

MICHIGAN: 12 ms. W. of Stephenson, Menominee Co. (1). Naubinway, (Mackinac Co.) (1). Boyne Falls (2) and Beaver Island (1) (Charlevoix Co.). *Douglas Lake (19) and Silver Lake (10) (Cheboygan Co.). Kalkaska Co. (2). 9 ms. S. of Mio, Oscoda Co. (1). Roscommon Co. (1). Oscoda, Iosco Co. (6). Newaygo Co. (1). Saginaw Co. (1). Sanilac Co. (1). Deerfield Twp., (Lapeer Co.) (1). Bath (4) and Rose Lake (3) (Clinton Co.).

ILLINOIS: *Richmond (31), McHenry (2) and *Algonquin (9) (McHenry Co.). Sun Lake (1), Clear Lake (1), and Ravinia (1) (Lake Co.). *Winnetka (18) and Kenilworth (2) (Cook Co.). Dearborn (1).

MINNESOTA: *Plummer (Red Lake Co.) (17). *Lake Itasca (Clearwater Co.) (1). *Norman Co. (1). *Ottertail Co. (1). *Friesland (Pine Co.) (1). Rice Creek (Anoka Co.) (2). *Lakeland (Washington Co.) (1). *St. Anthony Park (10) Minneapolis (2), and *Fort Snelling (1) (Hennepin Co.). Near Fish Hatchery (*Le Sueur Co.) (4).

IOWA: *Dickinson Co. (1). Forest City, (Winnebago Co.) (23). *Hancock Co. (2). Webster City (Hamilton Co.) (1). Manchester (*Delaware Co.) (1). Ames (*Story Co.) (10). Jasper Co. (1). Grinnell (Poweshick Co.) (9). Moulton (*Appanoose Co.) (1).

SOUTH DAKOTA: Sand hills, Martin (Bennett Co.) (3). *Springfield (Bon Homme Co.) (5). *Elk Point (Union Co.) (1). Canton (Lincoln Co.) (1). *Brookings (Brookings Co.) (1).

NEBRASKA: West Point (Cuming Co.) (11). *Fremont (Dodge Co.) (5). Sarpy Co. (1). *Bellevue (Sarpy Co.) (1). Omaha (Douglas Co.) (3). *Louisville (1), and *Weeping Water (15) (Cass Co.). *Nebraska City (Otoe Co.) (1). Peru (Nehama Co.) (2).

KANSAS: Meade Co. (1). *Barber Co. (1). Ottawa Co. (1). *Saline Co. (2). Eureka Lake, 15 ms. S. of Manhattan (*Riley Co.) (1). Pottawatomie Co. (1). Topeka (Shawnee Co.) (1). Leavenworth (*Leavenworth Co.) (1). Lawrence (Douglas Co.) (4).

OKLAHOMA: Payne Co. (1). *Stillwater (1), and Perkins (1) (Payne Co.). *Wewoka (Seminole Co.) (1). Cherokee Co. (1). Quinton (Pittsburg Co.) (2).

TEXAS: Phantom Lake, Davis Mts. (2). 18 ms. N. Alpine, Jeff Davis Co. (16). Canadian (Hemphill Co.) (2). Big Spring (Howard Co.) (1). *Bonita (Montague Co.) (1). Cisco (Eastland Co.) (2). Devil's River (Val Verde Co.) (1). Eagle's Nest (Real Co.) (2).

**Tettigidea lateralis cazieri**[47] new subspecies

Text-figs. 7-18; Plate I, figs. 3-5, 8-10.

*Tettigidea parvipennis* Scudder and Cockerell, Proc. Davenp. Acad. Sci., IX, p. 22 (1902) [Albuquerque, New Mexico]. (Not of Harris.)

This form constitutes a well-marked geographic race of *Tettigidea lateralis*, so widely different in typical material from Arizona, New Mexico and other western states, that it would clearly be regarded as a distinct species, if the evidence as to its intergradation with typical *T. l. lateralis* was not before us. This has already been analyzed under the specific treatment. Morse's *Tettigidea tecta*, described from Durango, Mexico,[48] is the nearest relative in past literature to *T. l. cazieri*, but in the absence of material from the territory between its type locality, and that of *T. l. cazieri*, it is impossible at this time to do more than point out their resemblances. The two, i.e. *T. tecta* and *T. l. cazieri*, agree in the general pattern of the fastigial structure and that of the pronotum, in the well-developed medio-longitudinal tectation of the latter, in the general facial profile and the extent caudad of the median carina of the fastigium, the relative thickness of the antennae, and the lesser degree of prominence and globosity

[47] Dedicated to our friend Dr. Mont Cazier, Director of the Southwestern Research Station and Curator of Insects of the American Museum of Natural History, in appreciation of his interest and assistance in our studies, and his courtesy and cooperation when the senior author visited the Southwestern Research Station in 1956 and 1957, at which times much of the series of the present species was collected.

[48] Biol. Cent.-Amer., Orth., II, pp. 15, 17 (1901) [♂, ♀; Ciudad Durango, 8100 feet, Mexico].

of the eyes. The most evident differences of *T. l. cazieri* from *T. tecta* are, as seen in dorsal view, the less oblique lateral frontal carinae of the fastigium, which also, particularly in the female, are slightly more widely separated from the median carina of the fastigium as seen in both dorsal and cephalic aspects, in the fastigium as seen from the dorsum, and here especially in the male, being somewhat narrower than in *tecta*, in the frontal costa, as seen in cephalic aspect, being appreciably narrower than in *tecta*, in the slightly greater degree of prominence of the eyes as seen from the dorsum and in cephalic aspect, and in the deeper V-emargination of the tegminal sinus of the caudal margin of the lateral lobes of the pronotum.

When compared with typical Florida material of *T. l. lateralis* the present subspecies is seen to differ in its less prominent and less globose eyes, narrower interocular region as seen in cephalic aspect, more prominent and thicker median carina of the fastigium, the somewhat broader frontal costa, the more definitely multicostate surface of the pronotal dorsum (most evident in the female sex), and the more arcuate prehumeral outline of the pronotal dorsum in the female, while the median femora are shorter and stouter.

The general appearance of *T. l. cazieri* as contrasted with *T. l. lateralis* is that it is stubbier, with less protuberant, definitely less globose, eyes (as seen from the dorsum), these with an appreciably less circular basal outline, an average broader frontal costa, sharper fastigial outline as seen from the dorsum, and an average thicker and more caudad-extended fastigial median carina, as well as thicker antennae. Every representation of any size shows appreciable variation, but by far the greater part of any such representation exhibits these average differences.

*Type.*— ♀ ; Southwestern Research Station, Cave Creek Canyon, Chiricahua Mountains, Cochise Co., Arizona. 5400-5600 feet. September 8, 1956. (J.A.G. Rehn.) [Academy of Natural Sciences of Philadelphia, Type no. 5804.]

Size and general form much as in *T. l. lateralis*, brachypronotal (in type) ; surface of the dorsum of the pronotum multicostate as described below.

Head as seen in profile with the dorsum of the vertex more deplanate and flatter than in the same sex of *T. l. lateralis,* the profile of the dorsal section of the face slightly more arcuate and fuller, the median carina of the fastigium appreciably more elevated as seen in profile; fastigium as seen from the dorsum with its lateral frontal carinae straighter and more oblique, narrowly but well separated from the thick median carina of the fastigium, the surface of which is broadly rounded transversely, while the carina extends caudad virtually to the least interocular space, as seen from the dorsum the lateral juxta-ocular margins of the fastigium obliquely diverge from the least interocular space cephaled to the greatest fastigial breadth, which is at the cephalic margin; frontal costa slightly broader and coarser than in *T. l. lateralis,* narrowly and sublinearly sulcate from appreciably dorsad of the paired ocelli ventrad to the median ocellus, the lateral carinae of the costa heavier than in *T. l. lateralis;* eyes appreciably less prominent as seen from the dorsum and also as seen in cephalic aspect. Antennae shorter and with the articles somewhat more robust than in *T. l. lateralis.*

Pronotum not surpassing the apices of the caudal femora, as seen in profile with the dorsal outline moderately rising obliquely from the cephalic border to a point half way between the caudal margin of the eye and the humeral angle, thence virtually straight to the caudal extremity; cephalic margin of disk distinctly obtuse-angulate produced, its immediate apex narrowly rounded; median carina well marked, but less sharply cut off from the surface of the dorsum than in *T. l. lateralis,* the surface adjacent to the median carina in the immediately prehumeral section subtumidly swollen to the median line, where the carina per se is not sharply defined, surface of deplanate section of the discal surface caudad of the transverse sulcus with numerous, often anastomosing longitudinal costations, some of which reach as far as the caudal fourth of the pronotum, humeral angle as seen from the dorsum well indicated but more broadly rounded than in *T. l. lateralis;* lateral lobes of the pronotum with the proportions as in *T. l. lateralis,* the slope of the cephalic margin, the arcuation of the ventrocephalic angle and the suboblique truncation of the ventral margin as in *T. l. lateralis,* tegminal sinus of the same degree of angulate emargination as in *T. l. lateralis,* somewhat deeper than in *T. tecta,* remainder of caudal margin of lateral lobes as in *T. l. lateralis;* scapular area of pronotum somewhat deeper than in *l. lateralis.*

Tegmina broader (i.e. deeper) than in *T. tecta,* but not quite as broad as in *l. lateralis.* Wings reduced, not evident.

Ovipositor with the dorsal valves distad stubbier and blunter than in *T. l. lateralis* as seen in profile, their outline more sharply and less sigmoidally declivent to the apex; subgenital plate in outline as in *T. l. lateralis.*

Cephalic limbs slightly shorter and somewhat more robust than in *T. l. lateralis;* median femora proportionately somewhat shorter and stouter than in *T. l. lateralis,* with the medio-longitudinal carinulation of the external (cephalic) face less marked, median tibiae shorter and stouter (as 50 to 55 in *T. l. lateralis* of comparable body size). Caudal femora with proportions and form as in *T. l. lateralis,* sculpture of external faces less deeply cut and more shallowly etched; caudal metatarsi somewhat deeper and heavier in build.

*Allotype.*— ♂ ; same data as type. [Academy of Natural Sciences of Philadelphia.]

Differing from the preceding description of the female sex and from typical males of *T. l. lateralis* from northern Florida in the following noteworthy respects.

Size and general form much as in the male sex of *T. l. lateralis,* brachypronotal; surface of dorsum of pronotum with similar but less numerous costations as described for the female of this species.

Head with its general features as already emphasized for the female, the profile, the more extensive and heavier median carina of the fastigium and the broader frontal costa as noted in the female, lateral frontal carinae of the fastigium similarly somewhat more oblique than in *T. l. lateralis,* but not as strongly so as in the female, the separation of these carinae from the median carina of the fastigium also narrower than in the same sex of *T. l. lateralis;* eyes as seen in both dorsal and cephalic aspect as in the female, less prominent and somewhat smaller than in the male of *T. l. lateralis.* Antennae differing as in the female.

Pronotum reaching as far caudad as the apices of the cerci, distinctly failing to reach the apices of the caudal femora; less elevated proportionately than in the female, in this respect little different from the male of *T. l. lateralis,* the elevation of the cephalic section of the dorsal outline also not as marked as described for the female; cephalic margin of disk distinctly and clearly obtuse-angulate produced, immediate apex very narrowly rounded; median carina as described for the female, but the prehumeral tumidity seen in the female is but little evident in the male; deplanate surface of dorsum with costations as in the female but these are more ramose and less individually marked, humeral angles as described for the female; lateral lobes of the pronotum as in the female except that the ventro-cephalic angle is less rounded, being more obtuse-angulate.

Tegmina essentially as in male of *T. l. lateralis.* Wings greatly reduced, reaching to a point half-way between the tegminal apices and that of the pronotum.

Acute-sublanceolate form of the supra-anal plate and general character of the cerci as in the male of *T. l. lateralis*. Subgenital plate, as seen in caudal aspect, somewhat broader than in the male of *T. l. lateralis*.

Limb differences from the male sex of *T. l. lateralis* as already described for the female of this species.

*Coloration.*—The patterns and tones of the coloration noticed in this subspecies are essentially those found in the broad range of forms of this genus. The generally uniform pattern, which is seen in the greater part of the adult material from the type locality, is blackish brown, slightly polished, with the scapular area of the pronotum lightened to snuff brown, and occasionally the dorsal carina of the caudal femora is ticked with the same color. The dorsal surface of the pronotum ranges from as dark as the above general tone to as pale as buffy-brown, pecan brown or warm buff. With all these extremes of tone, the paler dorsal area of the pronotum and of the caudal femora also show some correspondence in the tone of their dorsal surfaces. Also three males from the type locality and that from Jemez Hot Springs have paler dorsal surfaces to the pronotum, these as pale as buckthorn brown, while two of the four females from the type locality show tendencies in the same direction. All of the females from Albuquerque show somewhat paler general coloration, even when the pronotal dorsum alone is not markedly contrasted. Of the series before me but three males from the type locality and that from Jemez Hot Springs show creamy-white faces, although in several other males the face is slightly paler than the general tone, but it is markedly contrasted only in those already mentioned. A single female from Albuquerque bears marked creamy-white blotches mesad on the dorso-external face and the dorsal half of the external one of the caudal femora, together with similar ticking on most of the carinae of the dorsal and external surfaces of the same part. All the adult specimens studied show a variably sized pale area at or near the apex of the tegmina except one male from the type locality, in which there is no indication of a pale area.

*Dimorphism.*—All of the specimens from Arizona and New Mexico are brachypronotal except the single male from Jemez Hot Springs, and the female from Sandoval, New Mexico, which are macropronotal. All of the Walsenburg, Colorado adult individuals are macropronotal (8 ♂, 8 ♀), together with the single male from Barber Co., Kansas, all the Holt Co., Nebraska material (3 ♂, 1 ♀) and the single male from Scotts Bluff in the same state. The single individual from Custer Co., and the male

from Clinton, Oklahoma are also macropronotal. All other adults are brachypronotal.

*Measurements (in millimeters)*

| | Length of body (to apex of abdomen) | Length of pronotum | Breadth of fastigium | Length of caudal femur | Depth of caudal femur |
|---|---|---|---|---|---|
| ♀, Cave Creek Canyon, Arizona, *type* | 12.3 | 11.8 | .95 | 7.9 | 2.3 |
| ♀, Cave Creek Canyon, Arizona, *paratype* | 11.5 | 11.5 | .91 | 7.4 | 2.1 |
| ♀, Cave Creek Canyon, Arizona, *paratype* | 12.1 | 11.8 | .91 | 7.5 | 2.2 |
| ♀, Albuquerque, N. M., *paratype* | 11.6 | 11.5 | .86 | 7.5 | 2.3 |
| ♀, Albuquerque, N. M. *paratype* | 12.4 | 12.7 | .91 | 8.0 | 2.3 |
| ♀, Sandoval, N. M., *paratype* (macropronotal) | 13.4 | 14.5 | .95 | 7.7 | 2.5 |
| ♂, Cave Creek Canyon, Arizona, *allotype* | 9.4 | 8.8 | .67 | 5.8 | 1.7 |
| ♂, Cave Creek Canyon, Arizona, *paratype* | 9.3 | 8.5 | .62 | 5.3 | 1.6 |
| ♂, Cave Creek Canyon, Arizona, *paratype* | 9.4 | 8.3 | .58 | 5.5 | 1.6 |
| ♂, Albuquerque, N. M., *paratype* | 9.1 | 9.4 | .67 | 5.5 | 1.9 |
| ♂, Albuquerque, N. M., *paratype* | 10.5 | 9.0 | .67 | 6.1 | 1.9 |
| ♂, Jemez Hot Springs, N. M., *paratype* (macropronotal) | 9.6 | 9.7 | .67 | 5.8 | 1.8 |

These figures present the extremes in size seen in the adults of the species now before us.

*Variation.*—But two features of this type seem worthy of note. There is some little variation in the brachypronotal phase in pronotal length in relation to the caudal femoral apices. From the type described above, i.e. with the pronotal apex falling appreciably short of the femoral apices, the pronotum in brachypronotal females may slightly surpass the femoral apices. In no adult male of the same phase is the pronotum seen to surpass the femoral apices.

*Distribution.*—This subspecies typically is known from certain mountain areas of eastern Arizona and several parts of New Mexico, over sections of the Great Plains of eastern Colorado and western Nebraska, thence eastward becoming atypical and progressively intergrading in that direction into *T. lateralis lateralis,* as discussed in detail on another page.

*Habitats.*—Scudder and Cockerell reported this species (as "parvipennis" or very close to it[49]) from an "alkali field" at Albuquerque, New Mexico. The senior author in 1921 found it on barer wet spots in bottomland, with coarse grass and some patches of alfalfa, along the Rio Grande four miles south of Albuquerque, and Rehn and Rehn in 1939 swept it from a drain grown high with weeds and grass along the railroad right of way at Sandoval, New Mexico, also in the immediate Rio Grande valley. At the Southwestern Research Station in 1956 and 1957 it was found only along the course of Cave Creek and in adjacent wet areas, but chiefly in meadowy and boggy spots with short grass, partly shaded by rather dense low willows, under a tall tree canopy, largely of sycamores. In places the surface on which it was taken was almost muddy, apparently kept moist by underflow from springs, but also it was occasionally saturated by rain. Here, in restricted conditions, this species was extremely local, preferring the more heavily shaded spots, and was almost always accompanied by *Paratettix mexicanus.* The species was also taken a short distance farther down Cave Creek Canyon in a meadowy spot of somewhat more open character, although but a single adult and several immature individuals were there secured, also in company with *Paratettix mexicanus.*

*Seasonal Appearance.*—It is quite probable that *T. lateralis cazieri* is two-brooded annually. Adults are before us taken as early as March 19 at Roca, Nebraska and March 30 at Plattsmouth, Nebraska. Lincoln, Nebraska is represented by adults taken in April, June and September. In the Chiricahua Mountains, Arizona, adults and immature individuals were taken on July 13 and in September as detailed on a following line. At Walsenburg, Colorado adults and immature individuals were taken on August 13-15 and solely immature individuals at North

[49] On the basis of Morse's determination.

Platte, Nebraska on July 28, although only adult individuals were secured at Scotts Bluff, Nebraska, on June 6 and at Red Cloud, Nebraska on August 10. The specimen from 5000 feet elevation in the Sacramento Mountains of southern New Mexico was taken October 4. At Happy Crossing, in the Great Plains area of Texas, only immature individuals were seen on August 19, although Oklahoma localities are represented by adults taken in April, June, September and October.

At Albuquerque, New Mexico, *T. l. cazieri* has been taken adult on December 3 and in January, while on August 9, on the southern border of that city, adults and immature individuals were secured, the latter then outnumbering the adults, while the two instars preceding maturity are represented in the immature females. At the Southwestern Research Station in Cave Creek Canyon, Chiricahua Mountains, Arizona, adults and immature individuals were taken together when the preferred habitat was examined on September 1, 2, 3, 6, 8, 10 and 12, and immature individuals alone were taken on August 7. Special effort was made to secure adult material on all those dates, when the immature individuals vastly outnumbered the adults, as the following list of specimens examined will demonstrate.

*Possible history.*—It is logical to assume that *T. l. lateralis, T. lateralis cazieri* and *tecta* have had a common origin, that the latter is a member of the same broad specific line, and that *l. cazieri* was probably more broadly and more generally distributed over areas of southern Arizona and New Mexico and adjacent areas during the Pleistocene, when conditions were more favorable for tetrigids, due to heavier precipitation. However, except for the narrow crossing of the Continental Divide made by this subspecies, the genus is not known from the Pacific slope of North America.

*Paratypes.*—All the adult material of this species before us from Arizona and New Mexico is regarded as paratypic.

*Material examined:*

Typical *T. l. cazieri*

NEBRASKA: *Scotts Bluff, Scotts Bluff Co.; VI, 6, 1949; (R. E. Hill); 1 ♂; [Univ. of Nebraska]. North Platte, Lincoln Co., elev. 2800 feet; VII, 28, 1910; (Rehn and Hebard); 3 juv. ♂, 4 juv. ♀; [A.N.S.P.]. Southwest

Holt Co.; IV, 26-27, 1909; 3 ♂, 1 ♀; [A.N.S.P.]. Red Cloud, Webster Co.; VIII, 10, 1910; 1 ♀; [A.N.S.P.].

Colorado: Wray, Yuma Co., 3700 feet; VIII, 17-18, 1919; 1 ♂; [A.M.N.H.]. Walsenburg, Huerfano Co.; VIII, 13-15, 1925; (F. M. Gaige); 8 ♂, 8 ♀, 1 juv. ♂, 5 juv. ♀; [Mus. Zool. Univ. Mich.].

New Mexico: Jemez Hot Springs, Sandoval Co.; VII, 27, 1915; (John Woodgate); 1 ♂ (*paratype*); [A.N.S.P.]. Sandoval, Sandoval Co., 5000 feet; VII, 21, 1939; (Rehn and Rehn); 1 ♀ (*paratype*); [A.N.S.P.]. *Albuquerque, Bernalillo Co.; XII, 3, 1901; (T. D. A. Cockerell); 1 ♀ (*paratype*); [Mus. Zool. Univ. Mich.]: [50] I, 1899; (H. Soltan); 5 ♀ (*paratypes*); [U.S.N.M. and A.N.S.P.]: elev. 4800 ft.; VIII, 9, 1921; (J. A. G. Rehn); 3 ♂, 3 ♀ (*paratypes*), 8 juv. ♂, 5 juv. ♀; [A.N.S.P.]. *Sacramento Mountains, 5000 feet; X, 14; (C. H. T. Townsend); 1 ♀; [U.S.N.M.].[51]

Arizona: Southwestern Research Station, Cave Creek Canyon, Chiricahua Mountains, Cochise Co., elev. 5400-5600 ft.; IX, 1-12, 1956; (J. A. G. Rehn); 14 ♂ (*allotype* and *paratypes*), 4 ♀ (*type* and *paratypes*), 116 juv. ♂, 91 juv. ♀; [A.N.S.P.]. Chiricahua Mts., Cochise Co.; VII, 3, 1947; (R. H. Beamer); 7 ♂ (*paratypes*), 5 ♀ (*paratypes*), 3 juv. ♀; [Univ. of Kansas, A.N.S.P. and Mus. Zool. Univ. Mich.].[52]

## Atypical *T. l. cazieri*

Nebraska: Ashland, Saunders Co.; 1 ♂; [A.N.S.P.]. *Lincoln, Lancaster Co.; IV, 14, 1900; (R. H. Wolcott); 1 ♀; [Univ. of Nebraska]: IV, 15, 1931); (G. Gollehan); 1 ♀; [Univ. of Nebraska]: VI, 1 ♀; [A.N.S.P.]: IX, 1 ♂, 1 ♀; [A.N.S.P. and A.M.N.H.]: IV; 2 ♂, 4 ♀; [A.N.S.P.]. *Roca, Lancaster Co.; III, 19, 1912; (L. Bruner); 1 ♀; [Univ. of Nebraska]; V, 15, 1909; (L. Bruner); 1 ♂, 1 ♀ [A.N.S.P.]. *Plattsmouth, Cass Co.; III, 30, 1923, 1 ♀; [Mus. Zool. Univ. Mich.]. *South Bend, Cass Co., 1 ♀; [Univ. of Nebraska].

Kansas: Barber Co., 1468 feet elev.; 1916; (R. H. Beamer); 1 ♀; [A.N.S.P.]. Onaga, Pottawatomie Co.; (Crevecoeur); 1 ♀; [U.S.N.M.].

Oklahoma: Custer Co.; VI, 13, 1925; (Stringer); 1 ♀; [Univ. of Oklahoma]. Clinton, Custer Co.; VI, 4, 1939; (Kaiser-Nailon); 1 ♂, 1 ♀; [Mus. Zool. Univ. Mich.]. Norman, Cleveland Co.; X, 5 & 17, 1933; 1 ♂, 1 ♀; [A.N.S.P.]: IV, 26, 1929; (R. D. Bird); 1 ♀; [Mus. Zool. Univ. Mich.]: IX, 8, 1929; 1 ♀; [Mus. Zool. Univ. Mich.]: 1928; (M. J. Brown); 1 ♂; [A.N.S.P.].

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[50] This was the basis of Scudder and Cockerell's 1902 record of *T. lateralis* from Albuquerque.

[51] This is the specimen recorded by Rehn (Proc. Acad. Nat. Sci. Phila., 1902, p. 718 (1903) as *T. lateralis*.

[52] This material is unaccompanied by exact locality or altitude information, and we have no assurance it was from the same locality as that represented by the type.

TEXAS: Happy Crossing, Palo Duro Canyon, Randall Co., 3200-3500 feet elev.; VIII, 19, 1921; (Rehn and Hebard); 1 juv. ♀; [A.N.S.P.].

**Tettigidea armata** Morse

*Tettigidea armata* Morse, Journ. N. Y. Entom. Soc., III, p. 107, pl. 11, figs. 10 and 10a (1895) [♂, ♀; Vigo Co., Indiana (selected type locality); Dallas, Texas].

*Tettigidea armata depressa* Morse, Journ. N. Y. Entom. Soc., III, p. 107 (1895) [♂, ♀; Vigo Co., Indiana (selected type locality); Jacksonville, St. John's River and Fort Reed, Florida; New Orleans, Louisiana].

*Tettigidea davisi* Morse, Psyche, XV, p. 25 (1908) [♂, ♀; Perth Amboy (selected type locality) and Jamesburg, New Jersey; Staten Island, New York].

Reference is made to comments under *T. acuta* regarding the confusion of these two species. The synonymy of both *armata depressa* and *davisi* under *armata* were established by Rehn and Hebard in 1916.[53]

Lectotypes for the above-listed names have already been selected as follows:

*Tettigidea armata* Morse. Based on nine specimens, two males and seven females (one pair in coitu), six individuals from Vigo Co., Indiana taken by Blatchley, one female from Dallas, Texas, taken by Boll, and in the Scudder collection, and one male and female without data in the same collection. Morse and Hebard selected a female from Vigo Co., Indiana, taken September 6, 1893 by W. S. Blatchley, now Museum of Comparative Zoology Type no. 15778, as the lectotype.[54]

*Tettigidea armata depressa* Morse. Based on one male and four females from Vigo Co., Indiana (1 ♀), Jacksonville, Florida (1 ♂), New Orleans, Louisiana (1 ♀), St. John's River (1 ♀) and Fort Reed, Florida (1 ♀). The New Orleans specimen was from the Bruner collection and that from Fort Reed from that of Cornell University. Morse and Hebard in 1915 selected as the lectotype a female from Vigo Co., Indiana, taken by Blatchley and in the Morse collection.[55] This is now Museum of Comparative Zoology Type no. 15779.

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53 Proc. Acad. Nat. Sci. Phila., 1916, p. 152.

54 Proc. Acad. Nat. Sci. Phila., 1915, p. 98 (1915).

55 Proc. Acad. Nat. Sci. Phila., 1915, p. 98.

*Tettigidea davisi* Morse. Based on fifteen specimens representing both sexes from Perth Amboy and Jamesburg, New Jersey, and Staten Island, New York. Morse and Hebard in 1915 selected as the lectotype a female from Perth Amboy, New Jersey, taken by William T. Davis on May 31, and in the Morse series.[56] This specimen is now Museum of Comparative Zoology Type no. 15781.

We have studied anew the lectotypic material, as well as the greater part of the paratypic individuals on which the above listed names were based, and fully endorse the synonymy which had been established previously. The discussion here presented covers variational aspects which have been the cause of difficulties in recognizing the specific unity of the material here placed under *armata*.

*Pronotal condition.*—The present species, over its entire range, shows a slightly greater proportion of brachypronotal individuals. Of the 748 specimens examined, 332 (44.4%) were macropronotal and 416 (55.6%) possessed the short pronotum. In general, the pronota were near either extreme, i.e. failing to reach the knees or exceeding them conspicuously. In only two populations were there individuals intermediate in this respect, viz., Crane Township, Ohio, where all of the macropronotal specimens (17) had relatively short pronota, and Washtenaw Co., Michigan where 9 of the 11 macropronotals had the pronotum much shorter than average for this type.

An analysis of the percentage of each pronotal type found in different parts of the range fails to show more than local tendencies. Inland populations indicate that, on the average, the brachypronotal form of the species is slightly less predominant: Michigan, 60%; Ohio, 35%; Tennessee, 69%; average brachypronotal rate for these three states, 54%. Series chiefly from coastal and piedmont environments average 57% brachypronotal: New Jersey, 90%; Virginia, 74%; North Carolina, 14%; South Carolina, 46%; Georgia, 92%; Florida, 73%; Mississippi, 56%; Louisiana, 14%. Apparent inconsistencies in the average rate from state to state are probably due to the small samples available. The two large series at our disposal yield the following brachypronotal rate: Michigan, 107 specimens, 60%; Florida, 223 specimens, 73%.

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[56] Proc. Acad. Nat. Sci. Phila., 1915, p. 99.

*Morphological variation.*—Unlike the closely related form, *T. acuta,* the present species is widely variable in several aspects of its morphology. The following characters have been analyzed by us: lateral outline and form of the frontal costa; height of the vertex in relation to the dorsal surface of the eyes; development of the anterior pronotal spine; dorsolateral outline of the pronotum; pronotal surface.

In lateral outline the frontal costa of *T. armata* is almost identical with that of *T. acuta.* The normal condition is a low even arcuation from above the fastigium to the ventral terminus. A pronounced flattening of the outline above the antennal insertions becomes, in extreme cases, weakly emarginate. Variants of this type are found throughout the species' range and almost 40% of the specimens examined had the upper costal outline flattened in this manner. The height by which the dorsal terminus of the frontal costa exceeds the dorsal surface of the eyes is also variable. Normally this structure is only moderately elevated, but many specimens have the dorsal terminus fully as high above the eyes as is typically found in *acuta* (for comparison see figs. 23 and 29). In facial aspect, the frontal costa varies from a moderately broad structure with a thinner, somewhat laterally compressed dorsal terminus to one which is slightly broader throughout. In an extreme development of this latter condition the frontal costa is fully as broad, dorsally, as that found in *T. acuta.* It is, however, this broad in only a small percentage of the individuals in the series studied.

The height of the vertex in relation to the dorsal eye surface is another variable character of this species. It is usually on a line with or very slightly below the upper eye surface. A variant, found throughout the range of the species, has the dorsal surface of the vertex much higher than the top of the eyes and with its medial portion more domed than usual.

The pronotal spine of *T. armata* is normally well developed and slightly more robust than that found in *T. acuta.* It varies slightly in exact length, degree of development and extent to which it decurves. The only significant variation noted by us is in the development of this structure. Infrequent specimens have the spine reduced to an obsolete condition. As far as we can determine specimens exhibiting the reduced spine appear over the

entire range of the species and are no more frequent in one area than in another. There appears to be no trend toward a heavier or better developed spine in any particular area within the species' range.

The dorsal pronotal outline of this species is one of the chief characters which permits it to be separated from *T. acuta*. In macropronotal specimens, the outline tends to be nearly straight but with a very weak emargination over the tegminal area. A few specimens, nearly all macropronotal males, have the dorsal outline perfectly straight. In brachypronotal individuals of both sexes, the emargination in the dorsal pronotal outline is moderately to strongly developed. Another variable feature of the pronotum is the degree of carination exhibited by the median carina. Normally this structure is subcarinate, but two variants, connected by a series of intergrades, occur in all sections of the species' distribution. One of these variants shows an extreme development of the median carina in which it is high and sharply carinate. The other variant has the median carina low and subcarinate and in this respect approaches the condition typical for *T. acuta*.

The remarks made by Hebard[57] concerning the condition of the pronotum are not borne out by the present study. In those parts of the territory in which *armata* and *acuta* are found together, the two may be easily separated by the differences in pronotal outline, surface and median carina. We have seen no evidence of intergradation between the two. Nor is there any tendency for *armata* individuals in populations outside the range of *acuta* to approach this species in these critical characters. Hebard's conclusions in respect to these matters led him to assign the name *acuta* to *armata*, a position we feel is incorrect.

Pronotal sculpturation in *T. armata* is somewhat variable. The surface is always rough, usually granulose and set with small pustules and tubercles. The dorsum of the pronotum possesses many fine and irregularly aligned rugulae. The surface usually is dull or semi-glossy but never as polished or as brilliantly glossy as that of *T. acuta*. Variation occurs in the number and size of the granules and tubercles found on the pronotal surface,

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[57] Bulletin Illinois Natural History Survey, XX (3), pp. 172-173 (1934).

which in some specimens are large, thickly set and quite conspicuous. The more shiny surfaced individuals are somewhat smoother than usual, but do not approach *T. acuta* in this respect.

*Size variation.*—Variation in the size of five characters from three populations is given in Table 2.

*Coloration, pattern and tone.*—In general, the body color of *T. armata* is somewhat lighter than that observed in *T. acuta* covering a range from dark brown to fuscous-black. The brown colored specimens, often touched with ash-gray or black predominate. Two chromatomorphs are described below.

1. Entire dorsum of the pronotum much lighter in color than the rest of the body—often tan or cream color. Specimens of this coloration are before us from New Jersey, Florence, South Carolina, Thomasville, Georgia, Liberty County and Bonifay, Florida, Knox County and Allardt, Tennessee, and Rock Run, Ohio.

| | Length of body | | Length of pronotum | | Breadth of fastigium | | Length of caudal femur | | Greatest breadth of caudal femur | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| University of Tennessee Farm | 9.5 | 13.4 | 10.6 | 11.8 | .65 | .90 | 6.0 | 7.6 | 2.0 | 2.5 |
| | 9.3 | 12.6 | 11.6 | 11.4 | .70 | .95 | 6.1 | 7.6 | 2.0 | 2.3 |
| | 10.0 | 13.1 | 10.2 | 10.9 | .65 | .90 | 5.5 | 8.6 | 1.8 | 2.6 |
| | 10.4 | 14.0 | 9.9 | 13.3 | .70 | .90 | 6.3 | 7.8 | 2.0 | 2.5 |
| | 9.4 | 13.3 | 9.3 | 14.9 | .65 | .90 | 6.0 | 7.9 | 1.7 | 2.5 |
| Washtenau Co., Michigan | 9.5 | 12.3 | 10.0 | 13.2 | .70 | 1.00 | 6.4 | 7.7 | 2.1 | 2.5 |
| | 10.6 | 13.1 | 9.9 | 14.7 | .70 | 1.00 | 5.9 | 8.8 | 2.0 | 2.7 |
| | 9.9 | 12.0 | 9.3 | 13.0 | .70 | .95 | 5.9 | 8.0 | 1.9 | 2.6 |
| | 10.4 | 11.5 | 9.7 | 12.2 | .65 | .90 | 6.4 | 7.8 | 2.2 | 2.5 |
| | 10.3 | 13.1 | 10.0 | 11.9 | .75 | .95 | 6.1 | 7.8 | 2.0 | 2.6 |
| Morgan City, Louisiana | 10.0 | 12.6 | 11.8 | 13.0 | .60 | .85 | 6.1 | 7.7 | 2.0 | 2.5 |
| | 10.2 | 14.0 | 11.3 | 14.1 | .65 | .90 | 6.4 | 7.9 | 1.9 | 2.6 |
| | 10.4 | 13.5 | 12.1 | 14.8 | .60 | .85 | 6.3 | 8.0 | 2.0 | 2.0 |
| | 10.0 | 14.2 | 12.4 | 14.6 | .65 | .90 | 6.6 | 8.1 | 2.2 | 2.6 |
| | 9.8 | 13.0 | 11.7 | 14.2 | .60 | .85 | 6.4 | 7.9 | 2.0 | 2.4 |

Table 2. Size variation in three populations of *Tettigidea armata*. All measurements are in millimeters.

2. Posterior femora with one, two or three broad, light colored bands on the outer face. These color forms are very common and are found throughout the species' range.

The yellow, preapical macula of the tegmen is very conspicuous in this species and is slightly larger and lighter in color than that found in *T. acuta.*

*Habitats.*—No broad generalization as to preferred habitats of this species has been published, although a fair amount of regional information is in past literature. Blatchley, in 1898,[58] relative to its occurrence in Indiana stated it was taken "from [the] wooded margin of a large pond in the lowlands of the Wabash River," and that it had "also been taken about the margin of a lake near Waterloo, De Kalb Co." Morse, in 1904[59] reported it as occurring "on wet ground near a stagnant pool" at Denmark, South Carolina. Erroneously determined as *T. spicata,* Rehn and Hebard in 1905[60] noted it as occurring in "wet pine woods" at Thomasville, Georgia, and "in bayou country along the Ochlockonee River" in Thomas County, Georgia. In 1907 Morse gave it[61] as swept from "moist bottomlands" at Howe, Oklahoma, and Ola, Arkansas. Rehn and Hebard, in 1916,[62] presented the following habitat information; "the species [then correctly determined as *armata*] has been found in scant swamp-grasses along a 'branch' (Fayetteville [, North Carolina]), common on bare, black swamp soil (Lake Waccamaw [, North Carolina]), occasional on grassy edges of swamp (Lake Waccamaw [, North Carolina]), in low, wet sandy spots along streams (Florence [, South Carolina], Thomasville [, Georgia]), and occasional on sandy soil covered with scant grasses and dead oak leaves (Mixon's Hammock [, Georgia])." At Florence the following field note was made: "The Tettigideae would often jump into the water and drift down with the current, quite motionless until they would strike a twig or root to which they would cling. Their appearance was exactly like a bit of twig or bark floating down stream." Blatchley, in 1920[63]

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[58] Canad. Entom., XXX, p. 60.

[59] Publ. 18, Carneg. Inst. Wash., p. 28.

[60] Proc. Acad. Nat. Sci. Phila., 1904, p. 782.

[61] Publ. 68, Carneg. Inst. Wash., p. 27.

[62] Proc. Acad. Nat. Sci. Phila., 1916, p. 153.

[63] Orth. N. E. Amer., p. 185.

virtually repeated his comments of 1898, but added that *armata* "is usually found closer to water than is *T. lateralis*."

Hubbell in 1922,[64] in discussing it as present in Berrien County, Michigan, says it is "local in distribution, but occasionally common in small areas. It was found to be quite numerous about one of the dune ponds, especially on the areas of exposed muck and on the small mossy patches around the margins, but also among the herbaceous growth of the sandy shores, around some small piles of brush, and in the low herbage covering the ground under willows and aspens forming the pond-margin thicket. It was also taken in the lizard's tail marsh at New Buffalo, where it was most numerous around the drier margins. A single male was found on a patch of wet, trampled mud in the margin of a sedge marsh in a cleared ravine near the Warren Woods Preserve." Fox, in 1928[65] regarded it as "local in boggy woods throughout the Coastal Plain [in New Jersey]," Cantrall, in 1943[66] quotes extensively from Hubbell's 1912 paper and adds notes from Hubbell's manuscripts and his own observations, the gist of which is that on the George Reserve, Michigan he considered *armata* a rare insect, there taken "amid growths of *Eleocharis* and moss on the black, oozy mud of the lake margin," or "on dead leaves about five feet from the muddy soil of the ecotone between the oak-hickory . . . and the red maple-birch forest. . . ." He quotes from the Hubbell manuscript notes in regard to material taken at San Francisco, Michigan (here studied), "this species [was] fairly numerous about the margin of a shallow (probably temporary) pond in the edge of an open oak woods;" also he gives personal observations made in re *armata* as present near Mud Lake, Michigan, to the effect that it "was rare and occurred on a rather open, muddy area sparsely covered with mosses and the liverwort *Marchantia*. This area was formerly a part of a tamarack swamp which had been burned over." From these Michigan observations Cantrall concluded that "two factors are common to all situations in which the species has been found in fair-sized colonies. . . . These are the

[64] Occa. Papers Mus. Zool. Univ. Mich., 116, p. 35.

[65] Circ. 138, N. J. Dept. of Agr., p. 58.

[66] Misc. Publ. Mus. Zool. Univ. Mich., 54, pp. 88-89.

presence of heavy, mucky, organic soil, and a sufficiency of sunlight." The former of these we have found often, but not invariably, operates as a control for this species, but the latter is by no means an essential, or even general, requirement, in fact the localities in which we have taken *armata* have generally been shaded, often heavily so.

The hitherto unpublished information which we have drawn from the field observations of Hebard and Rehn cover a range of localities for this species extending from Florida and southern Georgia westward to Louisiana, western Tennessee and eastern Texas. At Bainbridge, Georgia, it was taken "on bare ground in dense 'branch' forest;" at Grand Ridge, Florida, it was found in a sink-hole depression in a thick cypress swamp; at River Junction, Florida it was occasional on bare places with dead leaves near stream [Apalachicola River]; at Lakeland, Florida, a few were found on bare, black muck in the heart of cypress bays and bordering 'hammocks,' while at Fort Myers, Florida it was found with *T. acuta* infrequent on bare, black muck in a hammock bordering heavy pine woods. At Montgomery, Alabama it was noted as very few in dead leaves in river bottom-land [Alabama River]; at Strickton, Mississippi, it was moderately common on often bare ground in a dense river swamp [Pearl River] largely under deciduous trees, some areas with coarse 'catch fly grass' (*Homalocenchrus lenticularis*) in which *armata* particularly occurred; on the Orleans Canal, near Spanish Fort, Louisiana, it was taken in muck on canal border; at New Orleans, Louisiana, very scarce in drained swamp land; at Harahan, Louisiana, it was common in a heavy swamp of tupelo gum and cypress, on bare black muck, there with *T. acuta*, while at Lake Charles, Louisiana, it was found in woodland undergrowth of oak 'hammock,' the ground covered in places with broom grass, some marshy spots. At Beaumont, Texas, it was captured on bare wet ground about a pool in low mixed pine and deciduous forest, and at Memphis, Tennessee, it was infrequent on dark wet bare ground in a heavy [Mississippi] river swamp.

It is evident from the above that *armata* has a marked preference for wet muck, more generally under shade and often in timbered swamps, than in open areas. Its requirements are much

like those of *T. acuta,* and the two are occasionally taken in the same environment in the territory where their ranges coincide.

*Seasonal Appearance.*—It is clearly evident that *T. armata* is two-brooded annually in at least the southeastern United States, and probably also over the greater part or all of its range. Unfortunately the amount of evidence in the way of representatives of immature individuals, or of adults and the latter taken together, is not sufficient for the distributional area as a whole to be fully convincing, but enough is available to indicate the pattern summarized above. In the northeastern United States and as far south as the Carolinas we know it occurs adult in all months between March (3, East branch of Potomac River, D. C.) and September (Staten Island, N. Y. and Raleigh, N. C. (month only), 21, Taylor's Mill Pond, Greenesville Co., Va.), while immature individuals are present taken September 9 at Fayetteville, N. C., and adults and immature individuals on July 20 at Clermont, N. J., Sept. 8 at Lake Waccamaw, N. C., and Sept. 6 at Florence, S. C. From Georgia it is known to occur adult from as early as February 29 at Thomasville to as late as December 14 at the same place, while adults were taken as early as May 18-26 at Clayton in mountain valleys in the northeastern portion of the same state; adults and immature individuals were taken together at Bainbridge, Ga. on Sept. 5-6. For Florida we find adults present every month in the year, and from Gainesville alone Dr. Hubbell and his colleagues secured it every month except June and August, a period when potential collectors were usually absent from the area; immature individuals alone represent July (25 from Camp "Torreya") and August (14 from Port St. Joe and 23 from Houston), while adults and immature individuals are before us taken in July (24 and 27 at Camp "Torreya"), August (2 at Marianna and 3 at Bonifay), September (13-15 at Fort Myers and 16 at Gainesville), October (16 at Camp "Torreya" and 27 at Gainesville), and December (7 at Newman's Lake). The Gulf Coast states (i.e. Alabama, Mississippi, Louisiana and Texas) are represented by adults taken in March and April and August, September and October, with adults and immature individuals representing July (23 from Beaumont, Texas), August (8 at Morgan City, Louisiana),

and September (12 at Strickton, Mississippi), while immature individuals alone are present taken September 13 at Delta, Louisiana. The few dates available from Arkansas and Oklahoma are for adults taken August 4-5 at Ola, Arkansas and 30 at Howe, Oklahoma. The relatively extensive information available from Tennessee shows *armata* is present adult in that state from as early as March (26 at the University of Tennessee Farm, Knox Co.) to as late as September 16 at Memphis, with May the only month in the interval not represented; adults and immature individuals taken together at Allardt represent dates reaching from July 18 to September 6, while immature individuals alone were taken on September 9 at the University of Tennessee Farm, Knox Co. The material before us, and published literature, of the species as found in Illinois, Indiana, Ohio and Michigan gives a range for adults from March (22, for Viola Township, Fairfield Co., Ohio) to October (4, for George Reserve, Mich., 13, for Dixon Springs, Ill., and 23, for Athens, Ohio), with pairs taken mated on July 20 in Vigo Co., Indiana; adults and immature individuals were taken together on August 13 east of Hillsdale, Mich., and Sept. 2 at New Buffalo in the same state.

*Distribution.*—From Staten Island, New York southward across coastal and southern New Jersey, coastal plain and piedmont sections of Virginia west to near the Blue Ridge (Dyke, Greene Co.), even more broadly over North Carolina to intermontane valleys at Hendersonville, the coastal plain, and probably mountain valleys, of South Carolina, Georgia from montane valleys at Clayton, Rabun Co., southward broadly to Florida and in that state as far south as Lee and Palm Beach Cos., across southern Alabama and Mississippi, broadly over Louisiana, reaching as far westward as the Ozark region of west-central Arkansas (Ola [67]) and extreme eastern Oklahoma (Howe [68]) and the eastern and northeastern section of Texas (west to Dallas and Beaumont); in the Mississippi Valley it ranges northward, very broadly over Tennessee east to the intermontane valleys (vicinity of Roan Mountain Station, Carter Co.), doubtless over much of Kentucky, with, however, but a single available record

[67] Morse, Publ. 68, Carneg. Inst. Wash., p. 27 (1907).

[68] Morse, Publ. 68, Carneg. Inst. Wash., p. 27 (1907).

from the extreme west (Hickman, Fulton Co.), while north of the Ohio River it is known from eastern Illinois and areas in both the northern (or Great Lakes section) and more southern Ohio River drainage area of both Indiana and Ohio, as well as the southern quarter of the lower peninsula of Michigan (most northern interior point for the species is in Livingston Co.). North of Arkansas it is not known from west of the Mississippi River, and its known occurrence in Illinois covers but the eastern third of the state. In Indiana and Ohio the distributional areas known in each are separated by a more central area from which the species is not represented. The more southern localities in both Indiana and Ohio are from watersheds tributary to the Ohio, while the more northern groups in each state are from areas which are within the Great Lakes drainage (see map 2).

It is probable that the post-Pleistocene drainage ways of the Illinois-Chicago and Wabash-Maumee furnished the type of avenues which gave the species entrance into the sections of northern Illinois, Indiana and Ohio where it now occurs and which had been glaciated but a geologically short time previously.[69] The predilection of this species—as well as *acuta*—for areas of wet muck, silt or sand could explain its preference for these avenues, then probably even more attractive to them ecologically than today.

*Localities represented:*

New York: *Staten Island (Richmond Co.) (1).

New Jersey: *Perth Amboy (3), *Jamesburg (1) (Middlesex Co.). Chestnut Neck (Atlantic Co.) (1). *Clermont (5), *Sea Isle Jct. (41), Cape May (1) (Cape May Co.).

District of Columbia: Washington (1), Eastern Branch of Potomac River near Bennings (1).

Maryland: Cabin John (1), Suitland Bog (2) (Montgomery Co.).

Virginia: Woodbridge (Prince William Co.) (1). Dyke (Greene Co.) (2). N.E. of St. Stephen's Church (King and Queen Co.) (1). Tributary to Chippakes Creek, W. of Claremont (3), E. of Bacon's Castle (1) (Surry Co.). 5 m. S.W. of Wakefield (Sussex Co.) (1). S.E. of Taylor's Mill Pond (Greenesville Co.) (1). Meherrin River near Little Texas (Southhampton Co.) (1). Suffolk (1), W. of Factory Hill (3) (Nansemond Co.). Dismal Swamp (Nansemond-Norfolk Cos.) (1).

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[69] Taylor has shown graphically (U. S. Geol. Surv. Monogr. LIII, pl. XIV (1915)) that these two drainage ways were outlets for glacial Lakes Chicago and Maumee.

North Carolina: Point Harbor (Currituck Co.) (1). *Fayetteville (Cumberland Co.) (1). Hendersonville (Henderson Co.) (2). *Lake Waccamaw (Columbus Co.) (3). *Wrightsville (New Hanover Co.) (3).

South Carolina: *Florence (Florence Co.) (32). Myrtle Beach (Horry Co.) (17).

Georgia: *Clayton (Rabun Co.) (1). Macon (Bibb Co.) (5). Tifton (Tift Co.) (2). Cox (1), Barrington (1) (McIntosh Co.). Bainbridge (2), *Spring Creek (1) (Decatur Co.). *Thomasville (Thomas Co.) (13). *Mixon's Hammock (Ware Co.) (8). Okefenokee Swamp (1).

Florida: De Funiak Springs (Walton Co.) (1). Bonifay (Holmes Co.) (3). Grand Ridge (9), Marianna (5) (Jackson Co.). Calhoun Co. (1). Port St. Joe (1) (Gulf Co.) (3). River Junction (1), Flat Creek on Florida route #269 (1) (Gadsden Co.). "Camp Torreya" (59), old Torreya (5), Sweetwater Branch (2), Hosford (1), Torreya State Park (1) (Liberty Co.). 2 m. W. of Apalachicola (Franklin Co.) (1). Tallahassee (Leon Co.) (2). *Monticello (Jefferson Co.) (1). Greenville (Madison Co.) (18). Houston (Suwannee Co.) (2). Newman's Lake (19), 6 m. W. of Newman's Lake (1), Gainesville (47), Warburg Lake (2), Hague (6), Fairbanks (1), San Felasco Hammock (1) (Alachua Co.) (4). *Welaka (Putnam Co.) (19). Sumner (1), 5 m. N. of Sumner (1) (Levy Co.) (1). 3 m. S.W. of Micanopy (Marion Co.) (4). Inverness (Citrus Co.) (4). Zephyrhills (Pasco Co.) (1). Plant City (Hillsboro Co.) (6). Lakeland (Polk Co.) (2). Manatee (Manatee Co.) (4). Fort Myers (Lee Co.) (6). Lake Worth (Palm Beach Co.) (2). *St. John's River (1).

Alabama: Montgomery (Montgomery Co.) (3). Flomaton (Escambia Co.) (1).

Mississippi: Strickton (Rankin Co.) (31).

Louisiana: Delta (Madison Parish) (1). Opelousas (St. Landry Parish) (1). Lake Charles (Calcasieu Parish) (1). Morgan City (St. Mary Parish) (59). Orleans Canal near Spanish Fort (1), *New Orleans (10) (Orleans Parish). Harahan (Jefferson Parish) (1).

Texas: Carter Lake (Marion Co.) (1). *Dallas Co. (2). Elkhart (Anderson Co.) (1). Beaumont (Jefferson Co.) (8).

Tennessee: Reelfoot Lake (3), Reelfoot Biological Station (3) (Obion Co.). Allardt (Fentress Co.) (53). 3 m. S.S.W. of Roan Mt. Station (Carter Co.) (1). University of Tennessee Farm (Knox Co.) (29). Dorton (Cumberland Co.) (1). Memphis (Shelby Co.) (5).

Kentucky: Hickman (Fulton Co.) (1).

Ohio: Pond near Nettle Lake (Williams Co.) (1). South Bass Island (Ottawa Co.) (1). Defiance Twp. (Defiance Co.) (2). Sandusky (Erie Co.) (1). Crane Twp. (Paulding Co.) (36). Rocky Fork (3), Eden Twp. (4) (Licking Co.). Viola Twp. (Fairfield Co.) (2). Southeastern Pickaway Co. (1). Ash Cave (Hocking Co.) (3). Athens (Athens Co.) (8). Rock Run (Jackson Co.) (16). Gallia (2), Adamsville (1) (Gallia Co.).

Indiana: *Dune Park (Porter Co.) (1). *Monroe Co. (1). *Knox Co. (7). Hanover (Jefferson Co.) (12).

ILLINOIS: *Chicago (1), *Riverside (1) (Cook Co.). *Dixon Springs (Pope Co.) (1).

MICHIGAN: E. S. George Reserve (1), Iosco Twp. (2) (Livingston Co.). Milford (Oakland Co.) (2). South Haven (Van Buren Co.) (1). *Francisco (Jackson Co.) (15). Lodi Twp. (3), *Mud Lake (2), Half Moon Lake (1), Ann Arbor (2) (Washtenaw Co.) (53). Lakeside (3), *E. K. Warren Preserve (17), *New Buffalo (3) (Berrien Co.). 13.5 m. E. of Hillsdale (Hillsdale Co.) (6).

OKLAHOMA: 6.5 m. NE. of Idabel (McCurtain Co.) (11).

**Tettigidea acuta** Morse Text-figs. 22-24.

*Tettigidea acuta* Morse, Journ. N. Y. Entom. Soc., III, p. 15, pl. 11, fig. 7 (1895) [♂; New York].

*Tettigidea apiculata* Morse, Journ. N. Y. Entom. Soc., III, p. 16, pl. 11, figs. 8, 8a (1895) [♂, ♀ (lectotype); New Orleans, Louisiana].

*Tettigidea spicata* Morse, Journ. N. Y. Entom. Soc., III, p. 108, pl. 11, figs. 9, 9a (1895) [♂, ♀ (lectotype); Georgia, Florida (selected type locality)].

The close relationship of this species and *T. armata* has been productive of much confusion in their past interpretation, and the relative plasticity of the present species has been responsible for the above synonymy, which is largely due to the small amount of material originally available and the consequent inability of its describer to determine what variation would be found in a fair-sized series. The synonymy of *spicata* under *apiculata* was established by Fox in 1928.[70] Hebard in 1934, although he then confused the present species and *armata,* and regarded them as variants of a single species, first synonymized *apiculata* under *acuta.*[71]

Lectotypes for the above-listed names have already been selected as follows:

*Tettigidea acuta* Morse. Based on three females from "New York," taken by Uhler and in the Scudder collection. Lectotype selected by Morse and Hebard in 1915 [72] a female from the original series, now Type no. 15785, Museum of Comparative Zoology.

*Tettigidea apiculata* Morse. Based on a pair from New Orleans, Louisiana, taken by Akhurst, and originally in the Scudder collection, the female specimen of this pair was designated

[70] Circ. 138, N. J. Dept. of Agr., p. 58.

[71] Bull. Ill. Nat. Hist. Surv., XX, p. 172.

[72] Proc. Acad. Nat. Sci. Phila., 1915, p. 98.

as the lectotype by Morse and Hebard in 1915,[73] this specimen now being Type no. 15789, Museum of Comparative Zoology.

*Tettigidea spicata* Morse. Based on one male from " Georgia," taken by Henshaw, and originally in the Scudder collection, and two females from " Florida " taken by Morrison originally in the Bruner collection. Morse and Hebard in 1915 selected one of the latter as the lectotype,[74] this now being Type no. H 402 in the collection of the Academy of Natural Sciences of Philadelphia.

We have studied anew all the type material involved and confirm the synonymy which had been previously established, aside from the assumption that *armata* and *acuta* were either subspecies of a single species [75] or identical.[76] Neither of these conclusions is supported by the present study, which demonstrates that *armata* and *acuta* are distinct specific entities, and that while their distributional areas broadly overlap, that of *armata* has a much broader extent than that of *acuta*, reaching broadly northward in the Mississippi Valley and a considerable distance westward into Texas, areas from which *acuta* is not known.

*Pronotal condition.*—This species is apparently more stabilized with respect to pronotal length than either *T. lateralis* or *T. armata*. Of the 149 specimens examined only 4 (from Anona, Florida) are brachypronotal. There is slight variation in the length of the pronotum which exceeds the knees in two southern series only. The Anona, Florida specimens which are macropronotal have this structure only slightly projected beyond the knees and are, therefore, intermediate between the two pronotal extremes. This situation also occurs in the Spanish Fort, Louisiana series where one of the three macropronotal specimens has the pronotum of intermediate length.

*Morphological variation.*—*T. acuta* exhibits very little variation over its range, differing in this respect from the closely allied species *T. armata*. Significant variation occurs in the following characters: Outline of the frontal costa; degree of development of the anterior pronotal spine; dorsal outline of the pronotum.

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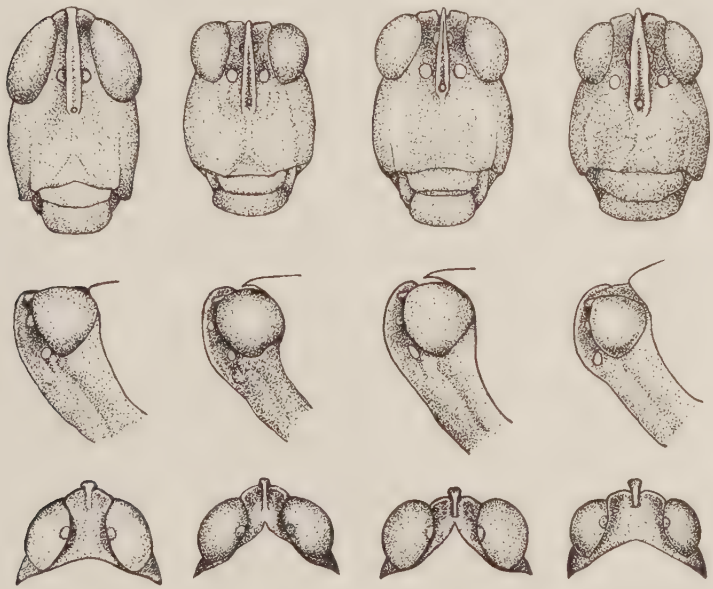
[73] Proc. Acad. Nat. Sci. Phila., 1915, p. 98.

[74] Proc. Acad. Nat. Sci. Phila., 1915, p. 99.

[75] Blatchley, Orth. N. E. Amer., p. 186 (1920).

[76] Hebard, Bull. Ill. Nat. Hist. Surv., XX, p. 172 (1934).

The frontal costa, in lateral aspect, is normally evenly arcuate from above the fastigium to its ventral terminus. The only variation is a slight flattening anteriorly which reduces the evenness of the arcuation. The most variable feature of the frontal costa is its dorsal terminus which, in lateral aspect, is typically produced as a median lobe-like structure above the anterior portion of the vertex (see fig. 23). The two extremes are connected



Figs. 19 to 30. Morphological features of *Tettigidea* species. Fig. 19, upper row left, head, frontal aspect; Fig. 20, middle row left, head, left lateral aspect; Fig. 21, lower row left, head, dorsal aspect—all of *T. prorsa*, ♂ paratype, Georgia: Fig. 22, upper row left center, head, frontal aspect; Fig. 23, middle row left center, head, left lateral aspect; Fig. 24, lower row left center, head, dorsal aspect—all of *T. acuta*, ♂, Mullica River near New Gretna, New Jersey: Fig. 25, upper row right center, head, frontal aspect; Fig. 26, middle row right center, head, left lateral aspect; Fig. 27, lower row right center, head, dorsal aspect—all of *T. armata*, ♂, Cape May, New Jersey: Fig. 28, upper row right, head, frontal aspect; Fig. 29, middle row right, head, left lateral aspect; Fig. 30, lower row right, head, dorsal aspect —all of *T. empedonepia*, ♂, paratype, Camp Torreya, Florida. All figures greatly enlarged.

by a series of intermediate forms. It should be noted that in males the frontal costa never rises, proportionately, as high above the fastigium as in females.

The pronotal spine of *T. acuta* varies in both its length and form. Northern populations seem to possess a slightly shorter spication. This becomes gradually more elongate in southern and western series. The nature of this difference may be clinal, but sufficient material is not at hand to demonstrate it. In form the spine is nearly always weakly decurved, but less so in males than in females. A few specimens, from various parts of the range, have the spine straight.

In outline, the dorsum of the pronotum is lowly, but evenly, arched in nearly all of the specimens examined. The only variation is a slight flattening in the interhumeral area resulting in a virtually straight outline. This condition, which is of very infrequent occurrence, is almost entirely restricted to males.

*Size variation.*—Table 3 lists the variation in size of five characters for this species.

*Coloration, pattern and tone.*—The predominant color found in the species is fuscous to black over the entire body. A few specimens are of a dark brown color, but these constitute less than 5% of the total series. Males nearly always have the face below the eyes of a much lighter color, usually light brown, cream or white.

The only marked chromatomorph noted has a broad, mid-longitudinal stripe of light brown or tan running the entire length of the dorsal pronotal surface. This color form occurs in all parts of the species' range.

The preapical yellow macula found on each of the tegmina is much more subdued, in intensity of color, than that found in *T. armata.*

*Distribution.*—As with other species of Tetrigidae it is at times questionable whether published records rest upon correctly determined material, unless the latter is before one. This is particularly true in connection with published records of two species as closely related as *T. acuta* and *armata.* We have endeavored to place correctly these past records, to evaluate the majority of which we have had at least part of the original material. The

| | | Length of body | Length of pronotum | Breadth of fastigium | Length of caudal femur | Greatest breadth of caudal femur |
|---|---|---|---|---|---|---|
| Mullica River, New Jersey | ♂ | 9.8 | 10.7 | .60 | 5.5 | 1.80 |
| | | 9.6 | 10.4 | .65 | 5.5 | 1.80 |
| | | 9.8 | 10.9 | .65 | 6.0 | 1.90 |
| | | 9.6 | 10.4 | .60 | 5.6 | 1.85 |
| | | 10.4 | 11.2 | .65 | 5.7 | 1.80 |
| | ♀ | 12.9 | 13.8 | .90 | 7.5 | 2.40 |
| | | 12.3 | 13.5 | .85 | 7.4 | 2.30 |
| | | 12.8 | 13.8 | .90 | 7.4 | 2.40 |
| | | 11.5 | 12.7 | .80 | 7.0 | 2.26 |
| | | 12.5 | 14.0 | .85 | 7.4 | 2.30 |
| Iona, Florida | ♂ | 9.6 | 11.7 | .70 | 5.9 | 2.10 |
| | | 9.8 | 11.5 | .70 | 5.8 | 2.00 |
| | | 10.5 | 12.4 | .75 | 6.3 | 2.26 |
| | | 10.1 | 11.6 | .65 | 5.7 | 1.90 |
| | | 9.7 | 11.1 | .70 | 5.9 | 2.04 |
| | ♀ | 11.5 | 14.6 | .90 | 7.5 | 2.50 |
| | | 13.1 | 15.4 | .90 | 7.9 | 2.65 |
| | | 14.3 | 16.5 | 1.00 | 8.6 | 2.85 |
| | | 11.4 | 14.9 | .90 | 7.7 | 2.55 |

Table 3. Size variation in five characters of *Tettigidea acuta*. All measurements are in millimeters.

distribution as here given has been drawn from material clearly representative of *acuta*. It is evident that *acuta* ranges over much of the immediate east coastal territory, spreads more broadly over Florida, and narrowly along the Gulf Coast it also extends westward into Louisiana a short distance west of the Mississippi River. In more detail it ranges from "New York," without exact locality but possibly Staten Island, and the shores of Raritan Bay, New Jersey at Morgan, Middlesex Co., southward along the "coastal strip" of that state to Cape May Co. (Dennisville and South Seaville), and also somewhat inland, apparently along stream course, into the "pine barrens" as far as Lakehurst, over the eastern shore of Maryland (Liberty Town, Worcester Co.), tidewater Virginia (Quantico), the Currituck Sound area of North Carolina (Point Harbor), "Georgia" (without exact localities [77]), Florida broadly in coastal and other

[77] In this connection see the locality listing for *armata*.

suitable swampy localities from Duval County in the north to Monroe and Dade Cos. in the south, then westward narrowly over the Gulf Coastal sections of Alabama and Mississippi to the New Orleans area of Louisiana, with a single record from west of the Mississippi, that at Morgan City, Louisiana, on Grand Lake (see map 3).

The distribution of *acuta* is clearly governed by the required ecological conditions as discussed under "Habits."

*Habits.*—The first published information on the habits of this species (as *spicata*) was that of Rehn and Hebard [78] of its presence at San Pablo, Florida, where it was taken in pine woods undergrowth. The same authors in 1914 next noted its occurrence (also as *spicata*) at Jewfish, Florida,[79] where it "was taken in company with *Paratettix rugosus,* in bare spots on sun-baked marsh soil, where it was found to be very scarce." In 1915 Hebard added further observations on the habitat preferences of this species (as *spicata*) in the Miami area and at Cape Florida on Key Biscayne, Florida.[80] Then it was found in hammock growth in or on the edge of a red mangrove swamp at Miami and in a red mangrove swamp at Cape Florida. The information presented by Blatchley [81] as referring to this species (as *armata spicata*) is so composite, including as it does material and observations relating to *T. armata,* that it is of litle value as relating to *T. acuta.* Fox in 1928,[82] on the basis of New Jersey information, regarded this species (determined as *apiculata*) as "occasional, sometimes locally frequent, in low, marshy ground along the borders of salt or brackish marshes." His material from four of the five New Jersey localities given then is now before us, being part of the Academy series.

Previously unpublished information on the habits of *T. acuta* as contained in the observations of Hebard and Rehn at a number of points where they collected the species, are as follows: on the border of pine and oak forest in high grasses on the edge of

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[78] Proc. Acad. Nat. Sci. Phila., 1907, p. 285 (1907).

[79] Proc. Acad. Nat. Sci. Phila., 1914, p. 389.

[80] Entom. News, XXVI, p. 401.

[81] Orth. N. E. Amer., p. 186 (1920).

[82] Circ. 138, N. J. Dept. of Agr., p. 58.

Maps 2 and 3. Map 2 (above). The distribution of *Tettigidea armata* is indicated by filled circles. Map 3 (below). The distribution of *Tettigidea prorsa, Tettigidea acuta* and *Tettigidea empedonepia.* Filled circles = *Tettigidea prorsa;* open circles = *Tettigidea acuta;* x = *Tettigidea empedonepia.*

salt marsh at the Mullica River near New Gretna, New Jersey, on deep black muck at edge of salt marsh at Anona, Florida, few on black bare muck in a wet palmetto hammock and in a similar situation in a cypress swamp at Fort Myers, Florida, occasional on edge of black muck and sandy marsh flats in grass and other halophytes at Iona, Florida, few in a heavy gum swamp with areas of high grass and cane at Mobile, Alabama, a single one in marshy spot in low pine woods back from beach, at Pass Christian, Mississippi, few in high marsh grasses on shore of Lake Pontchartrain, at Spanish Fort, Louisiana, common in short grass on levee along the Mississippi, at Harahan, Louisiana, and common on muck in heavy swamp of tupelo gum and cypress, at Morgan City, Louisiana.

It is evident from the above that its preferred habitat is swampy or marshy ground, fresh, salt or brackish, and that it seems to intrude but marginally into other areas, these from the experience of the senior author, who collected the species at a number of localities, to be always adjoining the preferred habitat.

*Seasonal Appearance.*—The information on the dates of occurrence of *T. acuta* is much less informative than that available for the majority of species of North American Tetrigidae. We know the species as adult in Florida in January (1 at Oneco), March (3, 4, 15 and 16 at Miami), April (18 at Pablo Beach), May (1 at South Bay, Lake Okeechobee), August (7 at Hibernia and 13 at San Pablo) and December (16 at Lake Okeechobee), while adults and immature individuals were taken together on July 11 (at Jew Fish) and September 13 (at Iona) and 17 (at Anona), and immature individuals only on March 28 at Miami and September 13-15 at Fort Myers. We have no other information on the dates of occurrence of immature individuals in any other of the states represented by the species except New Jersey. Adults are before us from various dates in August from localities in Alabama, Mississippi and Louisiana, from single localities in North Carolina (Point Harbor) and Maryland (Liberty Town) in April, and from a single locality in Virginia (Quantico) in late October (25). New Jersey is represented by adults taken various dates in May at Morgan, Seaside Park, Lakehurst and South Seaville, one in June (Dennisville) and one

in August (Mullica River), while adults and immature individuals were taken together on August 20 at Dennisville.

*Localities represented:*

New York: *no exact locality (paratype of *acuta*) (1).

New Jersey: *Morgan (Middlesex Co.) (1). *Mullica River near New Gretna (Burlington Co.) (81). *Seaside Park (6), Lakehurst (1) (Ocean Co.). *Dennisville (7), South Seaville (1) (Cape May Co.).

Maryland: Liberty Town (Worcester Co.) (1).

Virginia: Quantico (Prince William Co.) (1).

North Carolina: Point Harbor (Currituck Co.) (1).

Florida: *Pablo Beach (1), *San Pablo (1), *Jacksonville (2) (Duval Co.). Hibernia (Clay Co.) (2). Anona (Pinellas Co.) (8). Oneco (Manatee Co.) (1). Fort Myers (4), Iona (14) (Lee Co.). Everglade (Collier Co.) (2). *Jew Fish (Monroe Co.) (10). South Bay (1), Lake Okeechobee (1) (Palm Beach Co.). *Miami (9), Key Biscayne, Cape Florida (1) (Dade Co.).

Alabama: Mobile (Mobile Co.) (1).

Mississippi: Pass Christian (Harrison Co.) (1).

Louisiana: Spanish Fort (2), *New Orleans (2) (Orleans Parish). Harahan (Jefferson Parish) (1). Morgan City (Saint Mary Parish) (9).

**Tettigidea prorsa** Scudder Text-figs. 19-21.

*Tettigidea prorsa* Scudder, Proc. Boston Soc. Nat. Hist., XIX, p. 34 (1877) [♂, ♀; Georgia].

*Tettigidea prorsa elongata* Morse, Journ. N. Y. Entom. Soc., III, p. 16 (1895) [♀, ♀; Georgia].

This species is the Nearctic member of a line of the genus which probably also includes the Mexican *T. tecta* [83] and *T. nigra* Morse,[84] and *T. spicatoides* Hebard,[85] and the northern Argentinian *T. paratecta* Rehn.[86] It is quite probable that as our knowledge of other Neotropical entities of the genus becomes more comprehensive other species will be found to be members

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[83] Biol. Cent.-Amer., Orth., II, p. 17 (1901). [♂, ♀; Ciudad in Durango, Mexico, 8000 ft.]. A male from Eslava, D. F., Mexico is now before us, as well as two females from the Distrito Federal, Mexico. In another direction *tecta* shows relationship to *T. lateralis cazieri*.

[84] Biol. Cent.-Amer., Orth., II, p. 18, fig. (1901). [♂; Xucumanatlan and Omilteme, Guerrero, Mexico, 7000-8000 feet.] A paratypic male from Xucumanatlan is in the Academy series.

[85] Trans. Amer. Entom. Soc., LVIII, p. 228 (1932). [♀; La Forestal, Vera Cruz, Mexico.] The type, in the Academy series, has been compared.

[86] Proc. Acad. Nat. Sci. Phila., 1913, p. 304, fig. 10 (1913). [♀; Misiones, Argentina.] The unique type is in the Academy series, and has been studied by us.

of this same assemblage. In our fauna, *prorsa* is more divergent from the mean of the genus than the other North American representatives.

As seen from the dorsum, when compared with the extralimital species mentioned above, *prorsa* has its general build more evenly fusiform, the frontal carinae of the fastigium, in the same view, more narrowly separated from the median carina of the fastigium, this carina less elevated, as seen in profile, than in any of the other species except *T. nigra,* which, however, has a less strongly retreating face and distinctly less attenuate male cerci. The profile of the pronotum of *prorsa* is lower and more even throughout than in *tecta* or *paratecta,* and more even than in *spicatoides,* which latter species has more attenuate caudal femora than in any of the compared forms. The eyes of *prorsa* as seen from the dorsum, are less prominent than they are in any of the compared species except *tecta* and *spicatoides.* The even and virtually unbroken continuity of the lateral shoulders of the pronotum found in *prorsa* is approached only in *T. tecta,* while the depth and shape of the ovipositor valves in *prorsa* is nearer what is found in the female of *tecta* than is the more slender structure seen in *spicatoides.* The female of *nigra* is, apparently, not known as yet. Comparison with *T. empedonepia* has already been made under that species.

We have studied the lectotype of *prorsa* and that of *prorsa elongata,* and find the latter merely the macropronotal phase of the species, as pointed out by Rehn and Hebard in 1916.[87] We have also before us in the Academy series one of the paratypes (♂) of *prorsa,* as well as other material which has been physically compared with the lectotypes on which the above-cited names were based.

Designated types, or lectotypes here selected, on which the above listed names were based are as follows:

*Tettigidea prorsa* Scudder. The original series consisted of three males and three females in the Scudder series from "Georgia (H. K. Morrison)," and from which we have selected as the lectotype a male bearing these data. It is type # 15783 in the Museum of Comparative Zoology collection. In addition to the

[87] Proc. Acad. Nat. Sci. Phila., 1916, pp. 147-148.

above quoted information it also bears a "Scudder's type 1876" label. The lectotype is brachypronotal.

*Tettigidea prorsa elongata* Morse. This name placed on the macropronotal phase of the species, was based on two males and one female from "Georgia." Morse and Hebard [88] selected as a lectotype a female from Georgia in the Museum of Comparative Zoology series.

*Pronotal and wing condition.*—The brachypronotal condition is the normal one for this species, only 14 of the 455 adults examined (3%) being macropronotal. In length, the pronotum varies from very short, i.e. failing to reach the apices of the posterior femora (when these are drawn up on the long axis of the body) by one-third the length of one of them, to the maximum observed in the series, i.e. exceeding the apices of the posterior femora by one-seventh the length of one of them. Thus, even macropronotal individuals have relatively short pronota when compared with other members of the genus in the area under consideration.

Wing length appears to be closely correlated with the length of the pronotum. The wings may be reduced to mere scale-like structures about as long as the tegmina which are completely cryptic and visible only after relaxing the specimen and depressing its abdomen. This is the case with all specimens having a very short pronotum—the norm for the species. In macropronotal specimens, or in those in which the pronotum almost reaches the apices of the hind femora, the wings are fully developed and exceed the posterior termination of the pronotum. The brachypterous and macropterous forms are connected by a series of mesopterous intergrades. This last state is found in specimens which have pronota of intermediate length.

*Morphological variation.*—*T. prorsa,* in its morphology, appears to be a very stable species showing only minimal variation. The following variable characters are discussed below: extent to which the vertex exceeds the dorsal surface of the eyes; outline of the frontal costa in lateral aspect; dorsal outline of the pronotum and cristation of its median carina; surface condition of the pronotum.

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[88] Proc. Acad. Nat. Sci. Phila., 1915, p. 99 (1915).

In lateral aspect the height of the vertex over the dorsal surface of the eyes varies to a considerable extent. In males, this structure is normally at the same level as the dorsal eye surface, but in a few specimens of this sex it is slightly higher. In females, the dorsum of the vertex is always higher than the eyes varying in height over these structures from one-fifth to one-seventh the dorso-ventral depth of one of them.

The frontal costa, in lateral aspect, is always smoothly angulate-rounded at its dorsal terminus. Little variation is noted except in the degree of angulation. This is normally obtuse-angulate rounded, but it varies, with all intermediate stages found, to a condition in which the dorsal terminus is more rectangulate-rounded.

The dorsal pronotal outline of this species is usually evenly arcuate except in the extreme apical portion which rises weakly dorsad. Frequently, the area over the tegmina is slightly flattened. Variants are noted which do not show the apical process rising dorsad. The median pronotal carina is normally moderately cristate, but not sublamellate. This varies to a highly cristate and very sharp—almost sublamellate—condition noted in a few specimens of the Allardt, Tennessee series.

The pronotal surface is beset with many fine pustules and, dorsally, possesses numerous, small, longitudinal rugulae. Variants show an increased development both in number and structure of the rugulae.

*Size variation.*—The variation in size of five characters for two series of this species is given in table 4.

*Coloration, pattern and tone.*—The remarks of Rehn and Hebard [89] in regard to this species' coloration are supported by the present study. The usual coloration of the species is light tan or brown, marked with fuscous especially on the pronotal lobes and legs. It differs from other species of the genus in North America by its lighter coloration. A very conspicuous chromatomorph occurs over the entire range of distribution. This color form has the vertex and entire dorsal pronotal surface of a much lighter color than the rest of the body, usually being cream colored or very light tan. This color pattern was observed in 188 specimens in the series studied. Occasionally, the median carina of the pronotum is marked in black.

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[89] Proc. Acad. Nat. Sci. Phila., 1916, p. 148.

| | | Length of body | Length of pronotum | Greatest breadth of fastigium | Length of fastigium cephalad of eyes | Length of caudal femur |
|---|---|---|---|---|---|---|
| Allardt, Tennessee | ♂ | 8.5 | 7.8 | .63 | .12 | 5.3 |
| | | 8.3 | 7.0 | .58 | .10 | 4.9 |
| | | 8.2 | 6.5 | .60 | .08 | 5.0 |
| | | 8.5 | 7.3 | .62 | .10 | 5.2 |
| | | 8.7 | 7.9 | .60 | .08 | 5.2 |
| | ♀ | 11.2 | 9.7 | .82 | .15 | 6.7 |
| | | 11.0 | 9.8 | .87 | .15 | 7.0 |
| | | 10.7 | 9.5 | .82 | .13 | 6.6 |
| | | 10.0 | 9.4 | .83 | .18 | 6.5 |
| | | 10.4 | 10.0 | .83 | .16 | 6.7 |
| Macon, Georgia and De Funiak Springs, Florida | ♂ | 8.0 | 6.6 | .58 | .12 | 5.0 |
| | | 8.3 | 6.7 | .62 | .10 | 5.1 |
| | | 7.8 | 7.2 | .63 | .16 | 5.3 |
| | | 8.1 | 7.3 | .62 | .12 | 5.1 |
| | | 8.4 | 6.5 | .65 | .16 | 5.2 |
| | ♀ | 11.4 | 9.5 | .80 | .18 | 6.8 |
| | | 12.0 | 9.4 | .77 | .16 | 6.8 |
| | | 10.5 | 9.1 | .82 | .18 | 6.5 |
| | | 11.0 | 8.9 | .80 | .20 | 6.8 |
| | | 10.4 | 8.6 | .78 | .16 | 6.6 |

Table 4. Size variation in five characters in *Tettigidea prorsa*. The samples were drawn from the Allardt, Tennessee population and a mixed series from Macon, Georgia and De Funiak Springs, Florida. All measurements are in millimeters.

*Distribution.*—Coastal Plain areas of the eastern and southeastern United States, the Gulf Coastal area east of the Mississippi, northern Florida and one station on the Cumberland Plateau (Allardt) of north-central Tennessee. The most northern point from which the species is known is Beach Haven, New Jersey, the next station southward being in southern Virginia (Greensville Co.), while all the North and South Carolina records are from tidewater or Coastal Plain localities. In Georgia it is known to reach inland to the "fall line" at Augusta and Mason, while the two localities from which it is known in the Gulf States (Alabama and Louisiana) are at low elevations. In Florida its present known southern limit is Orlando. The presence of this very local species at Allardt, at 1600 feet elevation on the Cumberland Plateau of Tennessee, is hard to explain, other than that of a relict population left from a previous

broader distribution. With no known records of the species' occurrence at any Mississippi Valley point it is hardly warranted to assume this distribution may represent a Mississippi-Tennessee-Cumberland river system extension of range from the Gulf Coast. There would seem to be more warrant for regarding it as an indication of an interglacial or postglacial warmer stage which reached areas which today contain few elements now otherwise almost entirely limited to tidewater or at least Coastal Plain environments (see map 3).

Over most of its range the species is Lower Austral in its zonal placement, the exceptions being the coastal Beach Haven, New Jersey record, which locality is in definitely Upper Austral conditions, and the other that from Allardt, Tennessee, which place similarly is Upper Austral.

*Habitats.*—Henry Fox in 1928, in commenting on *T. prorsa,* stated[90] that from his experience with it in the southeastern United States, " it occurs in low boggy areas and wet meadows in pine woods." This statement broadly summarizes the experience of the senior author with the species as taken by him in North Carolina, South Carolina, Georgia, Florida, Alabama and Louisiana. Both the single New Jersey and Virginia captures were made by Mr. Bayard Long, while engaged in botanical investigations, and the Virginia individual (W. Taylor's Mill Pond, Greensville Co.) bears a label indicating it was taken in an " argillaceous swale." From North Carolina, South Carolina and Georgia the published information, or previously unpublished field notes, report it as occurring " in a wet meadow in company with *Tettigidea lateralis* and *Paxilla obesa* " (New Bern, N. C.), in " areas in the pine woods of low, blackish water-soaked ground covered with low bog plants " (Wilmington, N. C., Yemassee, S. C., and Homerville, Ga.), " in various low grasses near ' hammock land ' " (Augusta, Hebardville, Suwanee Creek and Homerville, Ga.), " in swamp grasses along a wooded stream " (Fayetteville, N. C.), and " among long-leaf pines " (Augusta, Ga.). Hubbell[91] reported it as found at De Funiak Springs,

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[90] N. J. Dept. of Agric. Circular no. 138, p. 58.

[91] Fla. Entom., IX, p. 43 (1925).

Fla., "in small numbers in the margin of a small swampy depression overgrown with brush and tall herbage," while at the same locality Hebard and Rehn noted it as "occasional in particular on borders of brushy stream courses, in gently rolling sandy country." At Carrabelle, Fla., "one small colony [was found] in marsh grasses and plants on the edge of swamp areas," at Dothan, Ala., "very few [were seen] in damp spots in lush undergrowth of long-leaf pine woods," and at Breckenridge, La., it was "scarce, swept from barer spots in virgin long-leaf pine woods, similar in character to the 'flat woods' of southern Georgia but without wire grass."

The conditions under which it occurred at Allardt, Tennessee, at an elevation of 1600 feet, in their broader features were of necessity different from those under which it had been taken at the coastal localities here listed from North Carolina around to Louisiana.

The species always has been found to be quite local in its distribution, and generally represented by quite small populations. The representation from Allardt, Tennessee would indicate the species was numerous, if not abundant, there. However, four days are represented by the series, which would indicate continued search over the greater part of a month.

*Seasonal Appearance.*—Adults of *prorsa* are before us from dates extending from January 1 to October 15, and representing every month between except February. The dates in January and March, however, represent Florida localities only (Jan. 1, Orlando; March 24, 14 ms. W. of Hosford). Adults and accompanying immature individuals represent dates in August (13-27) and early September (4 and 5), with a representation of 251 specimens taken on the last mentioned date at Allardt, Tennessee being overwhelmingly adult (25 out of 251). Immature individuals only were taken on August 15 (Denmark, S. C.) and September 8 (Wilmington, N. C.). While the earliest dates available for adults represent only Florida localities, adults are before us taken at Macon, Georgia on April 6-26 and May 12-22. The only date information we have regarding the Beach Haven individual, the most northern capture, is that it was taken in "Spring."

*Remarks.*—We regard *prorsa* as representing a Neotropical line which became established in our Southeastern States probably in Pliocene times. Clearly the closest relationship of *prorsa* is with the Mexican species discussed on a preceding page, and probably other South American species share this affinity as well as the Argentinian *T. paratecta.*

*Localities represented:*

New Jersey: *Beach Haven (Ocean Co.) (1).

Virginia: W. Taylor's Mill Pond (Greensville Co.) (1).

North Carolina: *New Bern (Craven Co.) (2). *Wilmington (New Hanover Co.) (2). *Lake Waccamaw (Columbus Co.). *Fayetteville (Cumberland Co.) (1).

South Carolina: *Denmark (Bamberg Co.). 1.1 m. N. of Limehouse (U.S. 17) (Beaufort Co.) (1). *Yemassee (Hampton Co.) (50).

Georgia: *State only (*paratype*) (1). *Augusta (Richmond Co.) (1). Macon (Bibb Co.) (10).[92] Pembroke (Bryan Co.) (1).[93] *Hebardville (1), *Suwanee Creek, and *Lot 328, 12th district, Okeefenokee Swamp edge (1) (Ware Co.). *Homerville (Clinch Co.) (12).

Florida: 1.4 ms. W. of Hosford (Liberty Co.) (4). Carrabelle (Franklin Co.) (2). 2.2 ms. S. of Altha (Calhoun Co.) (2). 0.4 m. E. of Ponce de Leon (Holmes Co.) (1). *De Funiak Springs (Walton Co.) (17). 3 ms. E. of Crestview (Okaloosa Co.) (1). 4.4 ms. S. of Whitfields (Santa Rosa Co.) (1). Orlando (Orange Co.) (1).

Alabama: Dothan (Houston Co.) (5).

Louisiana: Breckenridge (Livingston Parish) (1).

Tennessee: Allardt (Fentress Co.) (497).

## PAXILLA I. Bolivar

1887. *Paxilla* I. Bolívar, Ann. Soc. Entom. Belg., XXXI, pp. 195, 294.

Genotype (by monotypy).—*Tettigidea obesa* Scudder.

The closest affinity of *Paxilla* is clearly with *Tettigidea,* and it is more distinct from the various purely Neotropical genera of the subfamily than it is from the broadly Neogaeic *Tettigidea.* Of the components of the latter genus *T. prorsa* is nearest to *Paxilla* in certain features, and for that reason we are placing *prorsa* linearly nearest to the very distinct *Paxilla.* However, this in no way modifies our belief that *Paxilla* is a relatively old entity, and that it, or a progenitor, entered our territory probably in a pre-Pleistocene period.

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[92] A pair of this series has been compared with the lectotype of *T. prorsa.*

[93] Compared with the lectotype of *T. prorsa elongata.*

The basic morphological features of *Paxilla* appear to be the following.

Body tumid, thorax and pronotum covering it markedly inflated, pronotal surface lacking most of the usually evident carinae, smooth but not strongly polished. Head with facial profile arcuate throughout; fastigium moderately broader than one of the eyes, in outline as seen from the dorsum with its frontal carinae obtuse-angulate convergent meso-cephalad, median carina of fastigium well marked but not high; frontal costa relatively narrow, finely sulcate medio-longitudinally, supra-clypeal triangle[94] evident but not strongly marked or sharply delimited carinately; eyes not prominent; antennae composed of 22 to 23 articles. Pronotum with dorsal outline strongly and regularly arcuate in cephalic half, in transverse section its dorsal surface is obtuse-angulate, smooth or little punctate, lightly polished but not markedly so, its general form strongly cucullate with a very low and weakly marked median carinula, cephalic margin without a median tooth, prehumeral lateral carinae of disk obsolete, humeral angles well rounded, transverse sulci not marked dorsad but shallowly evident on lateral lobes, latter with tegminal sinus well indicated, inferior sinus (of Hancock) well marked, broad and very obtuse-angulate emarginate. Tegmina evident in adults, but dorsal half normally concealed under pronotum. Wings atrophied. Cephalic and median femora with dorso-median sulcation definite but not wide or deep.[95] Caudal femora robust, deep for length (depth contained 2.6 times in length), dorsal carina but shallowly elevated, external carinae and external pattern of the pagina very shallowly marked, ventro-external face full, not at all excavated; caudal tibiae with internal margin having the interval between the distal spine and the next one proximad not markedly greater than that between the latter and its more proximal neighbor.[96]

*Distribution.*—The range of *Paxilla* is that of its single species, which is discussed on a following page.

**Paxilla obesa** (Scudder) Text-figs. 31-33.

*Tettigidea obesa* Scudder, Proc. Boston Soc. Nat. Hist., XIX, p. 34 (1877) [♂, ♀; Georgia].

This species was based on a series of three males and three females taken in Georgia by Morrison. A single pair of this original material remains in the Museum of Comparative Zoology

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[94] See Rehn, Proc. Acad. Nat. Sci. Phila., **100**, p. 94 (1948).

[95] This is more closely approximated in *Tettigidea prorsa* than in the other North American species of that genus.

[96] In *Tettigidea* the interval is much greater proportionately than in *Paxilla*.

series, of which the male (M.C.Z. type no. 15786) is here designated as the lectotype. It bears a "Geo" label and also the characteristic printed "Scudder type 1876" one. Its measurements are: length of body, 7.4 mm.; length of pronotum, 6.3; width of fastigium, 0.52; extent of fastigium cephalad of the eyes, 0.09; length of caudal femur, 4.7; breadth of caudal femur, 1.7.

Hancock[97] made a completely unwarranted statement regarding type material of this species. He noted: "The type specimen which I have been able to figure . . . . Mr. A. Bolter, of Chicago, found this specimen on the banks of the Halifax River at Port Orange, Florida. . . . The other specimens as far as known were taken by H. K. Morrison in Georgia, as given by Dr. Scudder." The explanation of the figure he gave (plate II, figs. 3 and 3a) list it as from Port Orange, Florida. The Bolter specimen formed no part of the original series of the species, and was, and is, without type standing. The collection of the Academy of Natural Sciences of Philadelphia contains a paratypic pair of this species, received in exchange from the Museum of Comparative Zoology many years ago.

*Pronotal condition.*—Only the brachypronotal condition is known to exist in *Paxilla*. The pronotum is short, not reaching the apices of the caudal femora when these are drawn up in line with the long axis of the body, and appears to vary only a little in its relative length.

*Morphological variation.*—*P. obesa* is remarkably stable in its morphological characters throughout its range. The little variation which does occur is noted in size (see table 5 below), outline of the frontal costa in lateral aspect and dorso-lateral outline of the pronotum.

The frontal costa varies in both the height of its dorsal portion over the eyes and in the outline of its anterior surface when seen in lateral aspect. Typically, the dorsal surface of this structure rises above the eyes a distance equal to one-fifth the greatest dorso-ventral dimension of one of the eyes (measured in lateral aspect). Variants occur in which the normally rounded lateral outline of the frontal costa's dorsal section is slightly flattened and hence lower, exceeding the dorsal surface of the

[97] Tettig. N. Amer., pp. 137-138 (1902).

eyes by only one-sixth the dorso-ventral height of one of them. The anterior surface of the frontal costa is almost perfectly arcuate in lateral outline for the great majority of specimens examined. The only variation noted here is a slight flattening of the arcuation which occurs in the region of the paired ocelli and just ventrad to them.

The dorso-lateral outline of the pronotum is subject to rather wide variation. This outline is always arcuate, usually with a pronounced though smoothly heightened area over the anterior two pairs of legs. Variants occur throughout the species' range which possess a much lower outline with little accentuation in height at any point along its length. Males consistently have a lower dorsal pronotal outline.

*Coloration, pattern and tone.*—The typical coloration of this species is dark black-brown to deep coffee-brown over the entire body with small irregularly placed patches of lighter brown. Males frequently have the face below the eyes light tan, brown or cream colored and this same color is then found on the ventral third of the pronotum's lateral lobes.

Only one conspicuous chromatomorph was noted by us in the series studied. In this color form the dorsal pronotal surface is of a much lighter color than the rest of the body. This distinctive pattern is of frequent occurrence, having been noted in approximately 10% of the individuals studied. It occurs throughout the species' range.

*Size variation.*—Variation in the size of five characters of this species is given in Table 5 below.

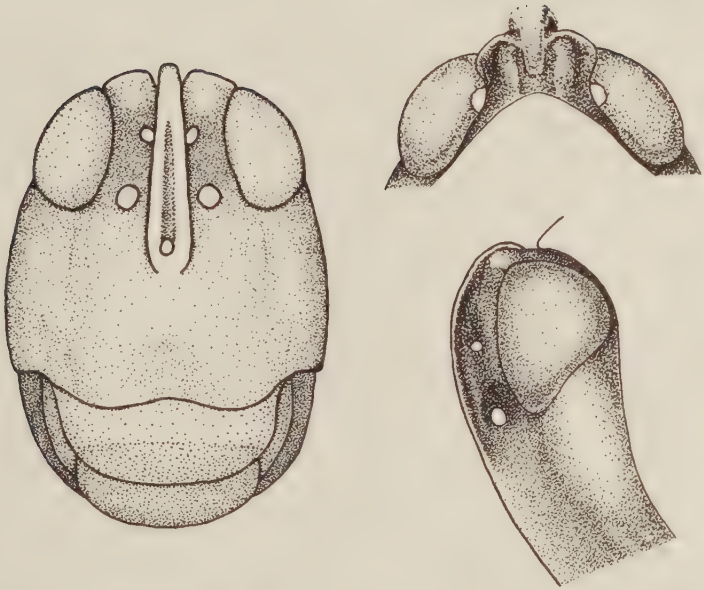
*Distribution.*—This genus and species is almost entirely limited in distribution to the coastal plain of the southeastern United States and the related area of the eastern half of the Gulf Coast, where it is largely confined to territory regarded as that of the Sabalian Life Zone and also adjacent sections of the Austroriparian or Lower Austral. Its distribution is known to extend from Camden, Camden Co., North Carolina to extreme southern mainland Florida (Homestead, Florida City, and Paradise Key), westward to southern Mississippi (Brookhaven) and adjacent Louisiana (Breckenridge). We do not know it from west of the Mississippi River, and the farthest inland point

in the Carolinas is Denmark, Bamberg Co., South Carolina, a truly coastal plain locality. However, the one locality outside of the general distributional pattern of the species—and genus—is Thomas, Floyd County, Georgia, where Hubbell secured it " in a patch of open swampy woods of sour gum and other trees, bordering a grove of long-leaf pines." This locality is far more elevated than any other from which the species is known, being virtually among the ridges of the Appalachian terminus, and almost at the head of the Coosa River (Alabama River) drainage. It is conceivable that the occurrence of *Paxilla* here represents a relict colony surviving from an inter-glacial or a post-glacial warmer period, when the genus extended more broadly into higher ground, and when its favorite habitat may also have been less localized and not as coastally restricted as it is today. We have studied Thomas, Georgia material, and it is inseparable from lowland Georgia representations.

| | Length of body | | Length of pronotum | | Width of fastigium | | Length of caudal femur | | Greatest width of caudal femur | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| Yemassee, S. Carolina | 10.0 | 13.5 | 8.8 | 12.3 | .76 | 1.00 | 6.6 | 8.2 | 2.5 | 3.1 |
| | 10.4 | 13.4 | 8.6 | 12.0 | .75 | 1.00 | 6.4 | 8.3 | 2.4 | 3.0 |
| | 9.9 | 13.9 | 9.0 | 11.7 | .76 | 1.01 | 6.2 | 8.4 | 2.4 | 3.1 |
| | 9.8 | 13.2 | 8.6 | 11.8 | .75 | 1.00 | 6.4 | 7.9 | 2.3 | 2.8 |
| | 10.1 | 13.4 | 8.9 | 12.1 | .75 | 1.00 | 6.5 | 8.3 | 2.5 | 3.0 |
| Gainesville, Florida | 9.4 | 12.7 | 8.4 | 11.5 | .80 | 1.00 | 6.5 | 7.2 | 2.3 | 2.6 |
| | 9.6 | 13.9 | 8.7 | 11.7 | .76 | 1.10 | 6.7 | 8.6 | 2.5 | 3.2 |
| | 9.8 | 12.4 | 8.6 | 10.0 | .75 | .91 | 6.4 | 7.1 | 2.4 | 2.5 |
| | 9.5 | 14.3 | 8.5 | 11.4 | .75 | 1.06 | 6.5 | 8.7 | 2.4 | 3.1 |
| | 10.0 | 12.5 | 8.8 | 11.6 | .75 | 1.15 | 6.6 | 8.5 | 2.5 | 2.8 |

Table 5. Variation in size of five characters in *Paxilla obesa*. All measurements are in millimeters.

*Habitats.*—This very distinctive genus and species has the same general preference for damp areas as the majority of tetrigids. Locally, however, it may display exception to its general limitation to damp spots in pine woods, usually " flat woods," or cypress depressions, in that it may occur in somewhat drier situations, but usually in well-grassed ones.



Figs. 31 to 33. Morphological features of *Paxilla obesa*, ♀ paratype, Georgia. Fig. 31, left; head, frontal aspect: Fig. 32, right above; head, dorsal aspect: Fig. 33, right lower; head, left lateral aspect. All figures greatly enlarged.

Morse gave us the first information on the habits of *Paxilla* in 1904 when he noted [98] " a single pair and two nearly full grown young [were] . . . secured on wet ground near stagnant pool," at Denmark, South Carolina. Rehn and Hebard [99] noted that at New Bern, North Carolina it was " taken in a wet meadow in company with *Clinocephalus elegans* and *Melanoplus decorus*," while the same authors several years later,[100] relative to the species at Homestead and Detroit (= Florida City), Florida, stated, " all were taken in the low undergrowth of the pine woods in not the usual very wet situations." In 1916 they presented

[98] Publ. 18, Carneg. Inst. Wash., p. 27.

[99] Proc. Acad. Nat. Sci. Phila., 1910, pp. 623-624.

[100] Proc. Acad. Nat. Sci. Phila., 1914, p. 389 (1914).

the most extensive distributional information on the species published up to that date, and summarized that on its habitats as follows: [101] "The present species appears to be entirely confined in distribution to the Sabalian and Tropical zones where it is further restricted to low, blackish, water-soaked ground covered with low bog plants (sun-dews, pitcher plants, etc.), in pine woods (long-leaf at all the localities [there cited] except Yemassee, where the forest was composed of the short-leaf species which is sometimes found in this region near swamps), so that even in its limited range its distribution is markedly discontinuous. . . . All but two of the series taken at Homerville [Georgia] were captured in an area a few yards in diameter, where the peculiar vegetation described above flourished, wide search through the swampy undergrowth of the pine woods elsewhere revealed only two young."

Hubbell in 1925 [102] noted for *Paxilla* that "The Jackson Co. male (4 ms. W. of Cottondale, Fla.) was swept from low grass on moist mucky soil, at the margin of the *Hypericum* belt surrounding a dry cypress pond in pine woods. The Georgia specimens (Thomas, Floyd Co.) were taken in a patch of open swampy woods of sour gum and other trees, bordering a grove of long-leaf pines."

Unpublished field observations of Rehn and Hebard, Rehn and Rehn, and the senior author alone supply further details regarding the various habitats in which *Paxilla* has been taken. At six miles SW. of Wilmington, North Carolina, it was found infrequent "in damp spots in open cut-over pine land, along a swaley old road with *Lycopodium* and bog plants." At Bainbridge, Georgia, a colony was located in coarse grass on rather dry blackish, but sandy, ground bordering a "branch," which wound through areas of oak—white, red, water and black-jack—and long-leaf pine, on rolling sandy soil with light ground cover. In "pan-handle" Florida it was found infrequent at De Funiak Springs near depressions in very gently rolling sandy country, where the undergrowth of open long-leaf pine woods was heavy wire grass (probably *Sporobolus gracilis*) and oak scrub, which

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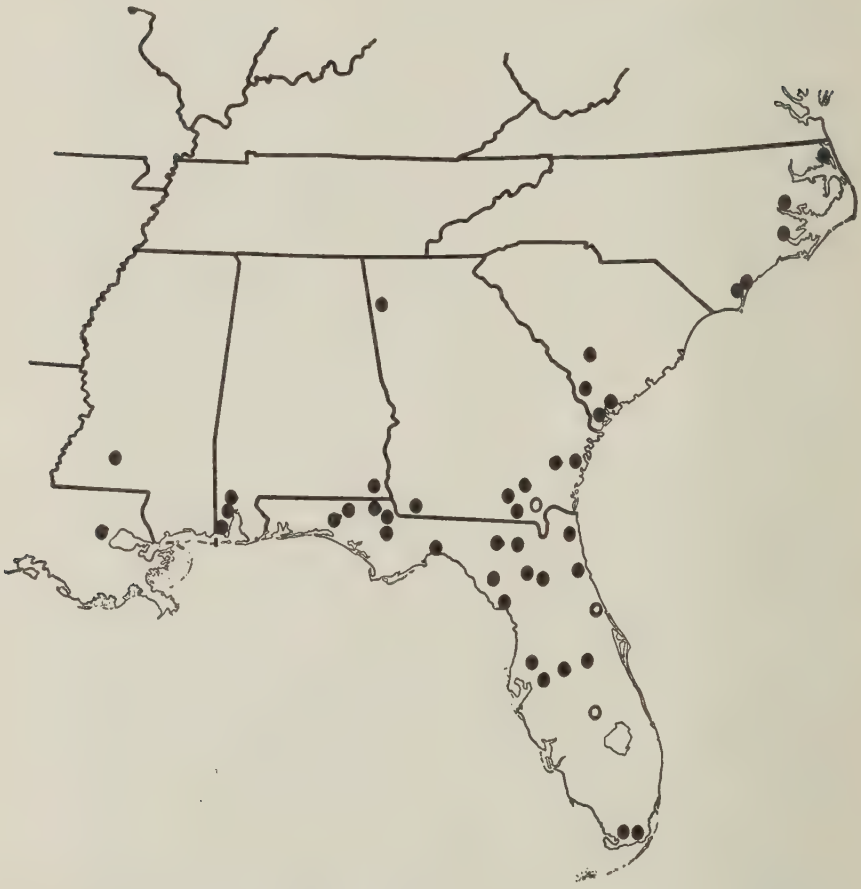
[101] Proc. Acad. Nat. Sci. Phila., 1916, p. 147 (1916).

[102] Fla. Entom., IX, p. 43.

toward the depressions had many water-loving plants, such as pitcher plants, etc., and frequent clumps of *Hypericum* where *Paxilla* occurred very locally; while at Grand Ridge, Florida, it was found in low grassy marsh on the border of a sinkhole, the general conditions being much like those at De Funiak Springs, also with cypress clumps in the depressions. In central Florida at Auburndale it was taken in open long-leaf pine woods with heavy undergrowth, at Kissimmee, Florida, in wet grass prairie and along the edge of flat woods, the latter with much low palmetto and wire grass. It was very scarce at Dothan, Alabama, in damp spots in lush undergrowth of long-leaf pine woods, the ground cover of which was largely gallberry bushes (*Ilex glabra*), brambles, etc. The species was much more numerous at both St. Elmo and Irvington, Alabama, at the former of which it occurred in damper spots of black soil with sun-dews, pitcher plants, etc. in heavy short grass in long-leaf pine woods, and at the latter on damp ground among swamp plants in a cypress depression in long-leaf pine woods. The single female taken at Brookhaven, Mississippi, was swept from grasses in second growth oak and short-leaf pine woods with occasional old long-leaf pines towering over them, with little scrub, much other grass, little or no wire grass, few absolutely bare spots and no wet spots at all. The two females from Breckenridge, Louisiana were swept from barer spots in a virgin stand of long-leaf pine, similar in general character to Georgia "flat woods," but with no wire grass, instead the more usual types of grasses, almost no gallberry bushes, but some little oak scrub. At this latter locality a dry "branch" was examined, but it yielded no *Paxilla*.

It is evident from the above information that the species is quite partial to a type of environment which is also much preferred by *Tettigidea*, and *Paxilla* and *Tettigidea l. lateralis* and *T. armata* and *T. prorsa* have been taken in the same conditions at numerous of the localities listed for *Paxilla* from New Bern, North Carolina to Homestead, Florida, and west to Brookhaven, Mississippi and Breckenridge, Louisiana. Also, as previously noted by Rehn and Hebard, it was found at additional localities in the same environment as the acridid *Clinocephalus elegans*.



Map 4. Map showing the distribution of *Paxilla obesa*. Solid dots indicate localities from which the authors have examined material and open circles those recorded in the literature but from which we have seen no material.

*Seasonal Appearance.*—As far as can be determined from available information *Paxilla obesa* has but a single brood annually over most, if not all, of its range. It apparently passes the winter in the adult condition, which is before us taken December 12 (Mobile, Alabama), January 5 (2 ms. N. of Denham,

Florida) and March 19 (½ m. N. of Paradise, Florida) and 24 (Barrington and Cox, Georgia), as well as on numerous dates in April and May, others in June (6 at Hawthorne, Florida and 14 at Hardeeville, South Carolina), July (12 at Florida City [olim Detroit], Florida, 13 at Ponce de Leon, Florida, and 24 at New Bern, North Carolina), August (2-3 at Suwannee Springs, Florida, 2 (mated), 3 and 4 at Gainesville, Florida, 15 at Denmark, South Carolina and ½ m. W. of St. Marks, Florida, and 22 at 39 ms. S. of Altha, Florida). From the latter third of the year we have adults taken on September 1 (Auburndale and Paradise Key, Florida), 5 (Lake City, Florida), 15 (Brookhaven, Mississippi) and 16 (Breckenridge, Louisiana), October 14 (1.4 ms. W. of Cottondale, Florida), 15 (6 ms. S. of Blountstown, Florida), 19 (Sumner, Florida) and 28 (Alachua Co., Florida), November 4 (Gulf Crest and Saraland, Alabama), and December 12 (Mobile, Alabama).

Adults and immature individuals taken together were secured July 10-12 at Homestead, Florida, August 2 (Waldo, Florida), 5 (6 ms. S. of Steinhatchee River, Florida), 6 (with two immature instars represented, 6 ms. SW. of Wilmington, North Carolina), 15 (Little Manatee River, Florida), 20 (1 m. N. of Limehouse, South Carolina), 26 (Irvington and St. Elmo, Alabama), 27 (Homerville, Georgia), 28 (Hebardville, Georgia), 29 (Levy Co. and 5 ms. N. of Sumner, Florida), and 30 (De Funiak, Springs, Florida), September 1 at Grand Ridge, Florida, 4 at Yemassee, South Carolina, 5-6 at Bainbridge, Georgia, and 9 at Thomas, Georgia, while immature individuals alone are before us captured in Alachua County, Florida as late as October 17.

It would thus appear that *Paxilla* is broadly single-brooded, although in extreme southern Florida adults and immature individuals have been taken together earlier in the summer (July 10-12) than to the northward, and there, if anywhere, there may be a second brood, but available information is not extensive enough to be definite.

*Localities represented:*

North Carolina: Camden (Camden Co.) (1). Washington (Beaufort Co) (1). *New Bern (Craven Co.) (4). *Wilmington (New Hanover Co.) (1). 6 ms. SW. of Wilmington (Brunswick Co.) (4).

South Carolina: *Denmark (Bamberg Co.) (7). *Yemassee (Hampton Co) (36). Hardeeville (2), and 1 m. N. of Limehouse (12) (Beaufort Co).

Georgia: "Georgia" (2). *Thomas (Floyd Co.) (9). Barrington (McIntosh Co.) (5). *Gardi (Wayne Co.) (1). *Hebardville (Ware Co.) (6). Fargo (1), and *Homerville (6) (Clinch Co.). Bainbridge (Decatur Co.) (18).

Florida: *Jacksonville (Duval Co.) (4). *Lake City (Columbia Co.) (2). Grand Ridge (3), and *1.4 ms. W. of Cottondale (1) (Jackson Co.). 3.9 ms. S. of Altha (1), and 6 ms. S. of Blountstown (1) (Calhoun Co.). Ponce de Leon (Holmes Co.) (1). *De Funiak Springs (Walton Co.) (8). ½ m. W. of St. Marks (Wakulla Co.) (1). Suwannee Springs (Suwannee Co.) (1). 6 ms. S. of Steinhatchee River (Dixie Co.) (3). Sumner (1), and 5 ms. N. of Sumner (7) (Levy Co.) (18). Waldo (18), *Gainesville (82), 1.8 ms. E. of Gainesville (3), Hawthorne (1), 3 ms. W. of Paradise (2), and ½ m. N. of Paradise (2) (Alachua Co.) (7). *Hastings (St. Johns Co.) (15). 2 ms. N. of Denham (Pasco Co.) (1). Kissimmee (Osceola Co.) (25). Auburndale (Polk Co.) (1). Little Manatee River at U.S. Highway 41 (Hillborough Co.) (14). Paradise Key (1). *Homestead (5), and *Florida City [olim Detroit] (1) (Dade Co.).

Alabama: Dothan (Houston Co.) (2). Gulf Crest (1), Saraland (1), *Mobile (1), Irvington (25), and St. Elmo (8) (Mobile Co.)

Mississippi: Brookhaven (Lincoln Co.) (1).

Louisiana: Breckenridge (Livingston Parish) (2).

## Explanation of Figures

(All figures greatly enlarged)

### Plate I

Fig. 1.—Typical *Tettigidea lateralis lateralis.* Male. Pablo Beach, Florida. Head, frontal aspect.

Fig. 2.—Atypical *Tettigidea lateralis lateralis.* Male. Between Bald Eagle and Hannah, Pennsylvania. Head, frontal aspect.

Fig. 3.—Intermediate between *Tettigidea lateralis lateralis* and *Tettigidea lateralis cazieri.* Male. Hanover, New Hampshire. Head, frontal aspect.

Fig. 4.—Atypical *Tettigidea lateralis cazieri.* Male. Ashland, Nebraska. Head, frontal aspect.

Fig. 5.—Typical *Tettigidea lateralis cazieri.* Male, paratype. Southwestern Research Station, Cave Creek Canyon, Cochise Co., Arizona. Head, frontal aspect.

Fig. 6.—Typical *Tettigidea lateralis lateralis.* Female. Jacksonville, Florida. Head, frontal aspect.

Fig. 7.—Atypical *Tettigidea lateralis lateralis.* Female. Walnut School Grove, 1 m. SW. Abbottstown, Pennsylvania. Head, frontal aspect.

Fig. 8.—Intermediate between *Tettigidea lateralis lateralis* and *Tettigidea lateralis cazieri*. Female. Bethlehem, New Hampshire. Head, frontal aspect.

Fig. 9.—Atypical *Tettigidea lateralis cazieri*. Female. Lincoln, Nebraska. Head, frontal aspect.

Fig. 10.—Typical *Tettigidea lateralis cazieri*. Female, paratype. Sandoval, New Mexico. Head, frontal aspect.

REHN AND GRANT: BATRACHIDEINAE

# MODIFICATION OF THE OVIPOSITOR IN CERTAIN SPECIES OF BUCCULATRIX (MICROLEPIDOPTERA)

BY ANNETTE F. BRAUN
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Examination of the female genitalia of species of the genus *Bucculatrix* in connection with the preparation of a monograph of the genus, has disclosed extreme modification of the ovipositor, together with the transfer of its function to the vagina in a considerable number of the species of the genus. Certain highly modified setae, here designated the *vaginal setae,* have developed on the thin membrane of the vagina. These specializations seem not to have been described previously.

Typically, in the Lepidoptera, the ovipositor, except in those forms in which it has been modified for piercing, consists of two soft hairy lobes, between which is the opening of the oviduct, the terminal portion of which, the vagina, is of cuticular origin. The ovipositor, although undergoing various modifications and specializations, has, so far as recorded, retained its function.

In the majority of the species of *Bucculatrix,* the ovipositor consists of the typical two soft lobes, clothed with sensory hairs, illustrated by Figure 1. Note here the arrangement of the latero-anterior group of setae, characterized by one long and two shorter setae. These setae may be traced throughout the modifications of the ovipositor lobes. In the species illustrated by Figure 2, the ovipositor lobes have retained their typical form. However, note the narrow opposing non-setae bearing inner margins of the lobes. Microscopic knobs, of no apparent function, are present on the lining of the vagina. It should be noted here that the vaginal lining, being of cuticular origin, that is, an invagination of the body wall, is not destroyed by KOH in the making of the slides. Its structure can therefore be microscopically examined on the prepared slides.



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LXXXIV, 105-108
Issued July 25, 1958 1243.25

In a number of species, the larvae of which so far as known are feeders on members of the Compositae, chiefly in arid regions, the structures of the ninth abdominal segment (or the fused ninth and tenth segments as interpreted by some authors) have undergone extensive modification. Figures 3 to 9 illustrate these modifications of the ninth segment in ventral view. The posterior ventral margin of the membranous half of segment 8 is indicated.

The inner margins of the ovipositor lobes develop into rasping rods; the remaining areas of the ovipositor lobes become flattened and fused with the membranous portion of the ninth segment, and are not then differentiated except by setal homology. Finally, the entire ninth segment may become strongly sclerotized. The vagina can be exserted and take the form of two lobes resembling ovipositor lobes. In all such instances, the membrane of the vagina is clothed with vaginal setae, setae which have assumed in the various species highly modified and remarkable shapes, characteristic and constant for each species.

Figures 3, 4, and 5 illustrate various aspects of these modifications in *Bucculatrix salutatoria* Braun, the food plant of which is sagebrush (*Artemisia tridentata* Nutt.). The inner margins of the ovipositor lobes have developed into two strongly sclerotized rods, their sharp tips curving ventrad. The remaining parts of the lobes are flattened and fused with the membranous part of segment 9, and only distinguishable from it by the greater degree of sclerotization and the setal arrangement, which follows the pattern shown in Figure 1. In Figure 3, note the conspicuous knobs on the vagina, visible between the rods within the body wall. In Figure 4, the vagina is partially exserted, forming two lobes resembling in shape the lobes of an ovipositor. In Figure 5, with vagina fully exserted, the arrangement of the strongly sclerotized and lobed knobs is shown. These knobs, here designated as *vaginal setae*, a few of which are shown highly magnified to the left of the figure, stand out as conspicuous dark bodies on the thin membrane. This exserted membrane, beset with these specialized setae is so thin and transparent in the prepared slides that it is practically invisible. Therefore the true ovipositor with its sclerotized rods is clearly visible beneath the expanded membrane, as shown in the figures (Figs. 5, 6, 7, 9).

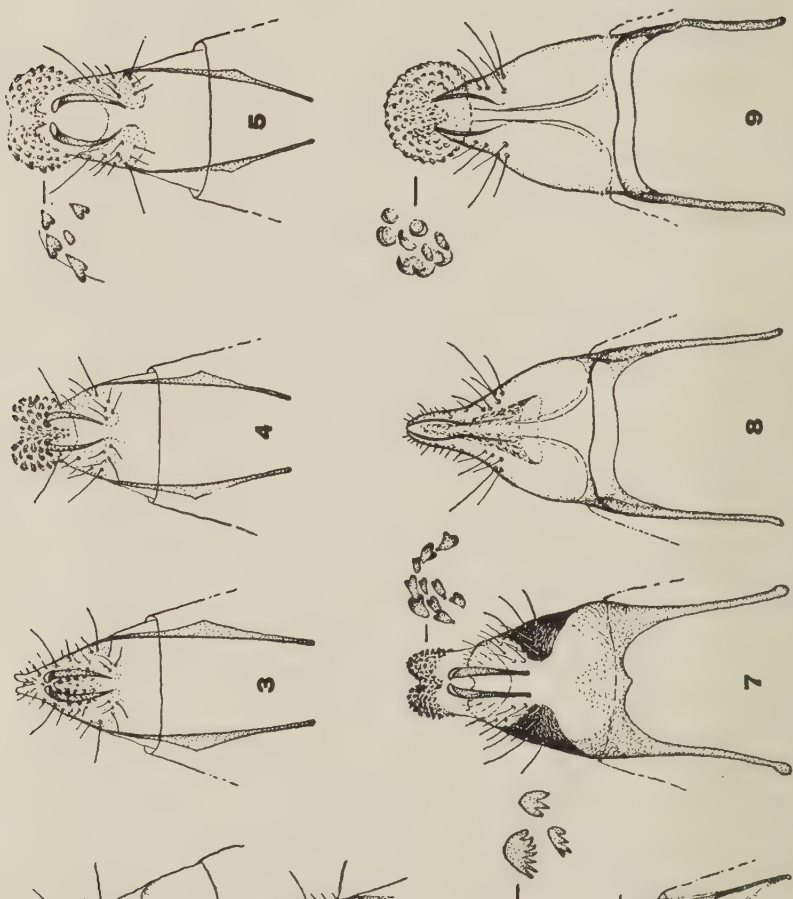
*Bucculatrix angustisquamella* Braun, probably also in the larval state a feeder on *Artemisia tridentata,* shows the same specializations, but with a different shape and arrangement of the vaginal setae (Fig. 6).

Figure 7 illustrates the extreme development in this line of specialization. Here, the entire segment 9 has enlarged and become strongly sclerotized, with the areas homologous with the ovipositor lobes partially dark-pigmented and except for setal arrangement not distinguishable, the apophyses appearing as anterior prolongations of the strongly sclerotized segment. Here, again, are the curved sclerotized rods of the ovipositor, the exserted vagina, its membrane closely clothed with specialized vaginal setae. The larvae of this species feed on the hairy or downy leaves of *Encelia,* shrubs of arid areas of southern California.

Figures 8 and 9 depict a somewhat different type of modification of the ovipositor lobes, in which the tips of the lobes are prolonged into sclerotized points. Figure 8 shows the vagina within the body and its anterior margin, which is the line of junction with the oviduct. In Figure 9 the vagina is fully exserted; to the left are shown several of the vaginal setae highly magnified. The form of these setae is characteristic of this species (*Bucculatrix latella* Braun).

The same specializations have been observed in many other composite-feeding species of the genus in western North America, the degree of development of the sclerotized rods varying somewhat. Similar specializations have been noted in the European *Bucculatrix artemisiae* H.-S.

The structures which have just been described are present in species of arid regions—species whose larvae feed upon plants with xeric leaf modifications. It is suggested that the function of the rods is to prepare the leaf surface to receive the egg by rasping and removing a sufficient number of the hairs on the lower surface of the leaf to permit the deposition of the flatly ovoid egg. Where the ovipositor lobes have been so greatly modified, the exserted vagina functions as an ovipositor; the vaginal setae, developed from the cuticular layer and sensory in nature, replace in function the setae of the normal ovipositor lobes.




Figs. 1-9.—Ventral aspect of the ninth abdominal segment of the female of species of *Bucculatrix*. Fig. 1, *Bucculatrix ivella* Busck; Fig. 2, *Bucculatrix* n. sp.; Figs. 3, 4, 5, *Bucculatrix salutatoria* Braun; Fig. 6, *Buccu-*

# STUDIES ON THE LARVAE OF DIGGER WASPS (HYMENOPTERA, SPHECIDAE) PART IV: ASTATINAE, LARRINAE, AND PEMPHREDONINAE [1]

BY HOWARD E. EVANS

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(Plates II to VIII)

This is the fourth of a series of five papers covering the comparative external morphology of the larvae of all available species of Sphecidae. None of the groups treated in this section is especially well known larva-wise, but enough information is available at least to characterize the subfamilies and some of the more common genera. Many of the drawings in this section were done by Enrico Sismondo.

## Subfamily Astatinae

The published descriptions of the larvae of Astatinae, reviewed on a later page, are brief and in some cases rather puzzling. I have been able to collect 38 specimens of two North American species of *Astata*, and my interpretation of the characters of the subfamily is based entirely upon these specimens. In all of these specimens the salivary opening is paired as in other Sphecidae (except Sphecinae). Michener (1952, Jour. Kansas Ent. Soc., 25: 115) states that the salivary opening in the Astatinae is in the form of a transverse slit with a convex margin. His statement is, I believe, based on Maneval's description of *Astata boops*. Although *boops* is closely related to the North American species, there are many differences between the larvae of *boops*, as described by Maneval, and the larvae of *unicolor* and *occidentalis*

[1] Acknowledgement is made to the Grace H. Griswold Fund of the Department of Entomology of Cornell University for assuming the cost of engraving the plates. Many of the larvae described here were collected in the course of studies on the comparative ethology of digger wasps, a project supported by the National Science Foundation.

as described below. Apparently Maneval had only one specimen, and my feeling is that it may have been immature or poorly preserved. In any event I prefer to base my understanding of the larvae of this subfamily on my own studies until such time as other workers are able to shed light on some of the discrepancies.

*Characters of the subfamily.*—Body fusiform, the posterior end rather blunt, the anus terminal and inconspicuous; middle body segments, especially abdominal segment four, very prominent dorsally; integument apparently smooth, but under high magnification seen to bear minute, irregularly distributed spinules and setae on some parts; spiracles with the atrium lined with weak ridges, the opening into the subatrium simple, unarmed, the subatrium unusually short. Head much wider than high; parietal bands strong; epistomal suture strong; antennal papilla present. Labrum broad, the apex emarginate and with a series of conical sensilla; epipharynx with small spinules except medially; mandibles with a hyaline, strongly setose area laterally near the base, the apex of the mandibles with from two to four strong teeth in nearly the same plane; mandibles only about 1.5 times as long as their maximum width; maxillae with the lacinial area short, clothed with short, straight spinules; galeae slightly shorter and much more slender than the maxillary palpi; apex of labium with the spinnerets paired, slightly exceeding the labial palpi; maxillae and labium forming a closely associated unit, the maxillae directed mesad toward the labium.

**Astata unicolor** Say (Plate II, figs. 1-8)

*Body.*—Length 17 mm.; maximum width (abdominal segment 5) 6 mm. Fusiform, grub-like; anus terminal; pleural lobes present on all body segments except the last, rounded and not especially prominent; mid-abdominal segments, especially segment four, distinctly humped dorsally (fig. 1). Integument smooth and glistening, but under high magnification seen to be sparsely and irregularly clothed with minute spinules and a few very small setae (fig. 4). First pair of spiracles distinctly larger than the others; spiracular orifice unusually small, the peritreme poorly defined; walls of atrium lined with weak, concentric ridges which bear minute spinules; opening into the subatrium unarmed; subatrium very short, leading directly to the trachea (fig. 7).

Body of the diapausing larva similar, but each body segment bearing paired dorsal, transverse elevations; laterally these elevations are nearly continuous with the pleural lobes (fig. 2).

*Head.*—Width 1.6 mm.; height 1.2 mm. (fig. 5). Mostly pale, but with a dark spot at the anterior mandibular condyle; mandibles brown, the apical half darker; palpi and galeae light brown; labium with a brown band at the base of the prementum. Epicranial suture weak, but the branches of the Y evident, each terminating in a shallow depression in the middle of the front; parietal bands long (nearly .5 mm.); epistomal suture very strong; top and sides of the epicranium weakly roughened by small convexities. Antennal orbits large, subcircular, about 125 $\mu$ in diameter; antennal papilla about 50 $\mu$ long by 30 $\mu$ in maximum thickness (fig. 3). Head setae small and sparse except on the lower sides, where they are more numerous and as much as 50 $\mu$ in length. Anterior margin of clypeus weakly concave; clypeus with a transverse series of setae.

*Mouthparts.*—Labrum .53 mm. wide, its anterior margin with a broad, V-shaped emargination, its basal margin arcuately extended beneath the clypeus; apical half of disc with numerous (about 25) small setae; anterior margin beset with about 18 small, conical sensilla and a few short spinules (fig. 6). Epipharynx with an abundance of small spinules which are largely absent from the median area; sides of the median area with two or three strong sensory cones anteriorly on each side and five or six weak pores on each side basad of these. Mandibles stout and strong, about .6 mm. long and .4 mm. in maximum width; apex with four very strong teeth, all in about the same plane; base more weakly pigmented than the remainder of the mandible, especially in a lateral area which bears numerous (about 12) setae (fig. 5). Maxillae short, sides strongly setose, lacinial area with abundant short spinules; palpi stout, about 100 $\mu$ long and 65 $\mu$ wide at the base; galeae very slender, about 90 $\mu$ long and only 20 $\mu$ wide at the base (fig. 8). Labium broad and smooth apically, without papillae but with several setae; palpi about 70$\mu$ long and 50$\mu$ wide at the base, terminating in five small sensilla; spinnerets paired, only slightly exceeding the palpi.

*Material.*—Twenty-two specimens, eleven of them diapausing, taken from several nests at Ithaca, N.Y., August 1956-57 (H. E. Evans). Biological studies made in connection with these specimens are being published elsewhere (Jour. N.Y. Ent. Soc., in press).

**Astata occidentalis** Cresson (Plate VI, figs. 46-48)

*Body.*—Length 19 mm. Similar in every respect to *unicolor*. Fourth abdominal segment with a very large dorsal prominence, the preceding two segments somewhat less strongly produced.

*Head.*—Width 1.9 mm.; height 1.45 mm. Shape and features much as in *unicolor;* antennal orbits relatively somewhat smaller than in that species, only 90 $\mu$ in diameter; antennal papilla 40 $\mu$ long and 30 $\mu$ wide at the base. Top and sides of the head capsule strongly roughened; setae abundant on the lower sides, the longest ones about 50 $\mu$ in length.

*Mouthparts.*—Labrum .62 mm. wide, the apical margin with a broad, V-shaped emargination; surface with many (about 40) strong setae; anterior margin with a row of about 30 small, darkly pigmented conical sensilla (fig. 48). Epipharynx densely spinulose, the spinules directed anteromesad, largely absent from the median area; sensory cones and pores as illustrated. Mandibles stout, about .7 mm. long and .48 mm. wide at the base; sides with a lightly pigmented area which bears 8 setae; apex of mandibles with two large teeth and with a very weak third tooth basad of these (fig. 46). Maxillae much as in *unicolor;* palpi 110 $\mu$ long; galeae more slender, 90 $\mu$ long. Labial palpi 80 $\mu$ long; spinnerets broad, slightly longer than the palpi, subtended by a pair of transverse, sclerotized bars (fig. 47).

*Material.*—Sixteen specimens taken from several nests at Versailles, Indiana, July 16-23, 1957 (H.E. Evans), in connection with biological studies being published elsewhere (Jour. N.Y. Ent. Soc., in press).

**Astata minor** Kohl

Grandi (1926, Boll. Lab. Zool. Portici, 19: 310-311) has described and figured the larva of this Palaearctic species. His larvae were immature, measuring about 8 mm. long. The body is fusiform, the posterior end somewhat conical. The head is wider than high and apparently very weakly setose; parietal bands are absent; the clypeus is slightly concave apically and the labrum very much so. The mandibles have only a minute tooth on the inner margin; the galeae and both pairs of palpi are very short, and the spinnerets are not visible.

**Astata boops** (Schrank)

The larva of this Palaearctic species has been described by Maneval (1939, Ann. Soc. Ent. France, 108: 70-72). The body is stout, fusiform, only 8 mm. long (and therefore probably not full-grown); the pleural lobes are rather narrow and elongate. The head is shaped much as in *unicolor* and the antennae of much the same form, but parietal bands are absent. The labrum is arcuately emarginate apically and bears a series of sensilla near the margin; the epipharynx is clothed with small spinules. The mandibles are rather slender and terminate in three teeth, the middle one rather small; there are apparently no setae laterally. The galeae and both pairs of palpi are very short (much as in

*minor*); the maxillae bear small papillae but no setae or spinules. The spinneret is a transverse slit which is arcuately produced.

**Astata immigrans** Williams

Williams (1946, Proc. Hawaiian Ent. Soc., 12: 645) presented a rough sketch of the larva of this species. There is general agreement in body form with *unicolor*, including the humping of the mid-abdominal segments. The shape of the head and form of the antennae are also about as in *unicolor*. The mandibles are shown as being tridentate apically, somewhat as described by Maneval for *boops*. The maxillae and labium are not shown in detail.

## Subfamily Larrinae

I have studied relatively few larvae of this subfamily, and this section is therefore of a very preliminary nature. The published descriptions of Larrinae often leave something to be desired; few of them, for example, adequately describe the setae on the head and body, and few of them describe or illustrate the details of the maxillae and labium. I have seen larvae of three of the five Nearctic genera of Larrini (including Tachytini); the other two genera are known from published descriptions. In the Miscophini, I have seen larvae of only one genus, *Solierella*, and the larvae of only two other genera have been described; eight genera are listed for North America. The material available to me varies much in quality of preservation, and in almost every case I have had to work with very short series.

On the basis of available material, the Larrinae appear to be fairly uniform in structure. Clearly they belong to the same complex as the Trypoxyloninae and Crabroninae; indeed, it is impossible to point to any single character which will always separate the larvae of Larrinae from those of Crabroninae. The angulate lobe at the base of the inner margin of the maxilla serves to separate the Trypoxyloninae, which otherwise are very similar.

*Characters of the subfamily.*—Body subcylindrical, posterior end rather blunt; anus ventral, preapical, the anal segment forming a rounded terminal lobe; pleural lobes prominent, those on the thorax often strongly protuberant, conical, the prothorax

often with one or two pairs of additional lobes dorsad of the usual pair; integument usually smooth dorsally, often with small spinules on parts of the venter; body setae conspicuous to nearly absent; spiracles with the orifice large, the peritreme absent or poorly defined, the opening into the subatrium either simple or armed with a circlet of spines. Head as wide as or wider than high (except in *Palarus*); parietal bands present or absent; antennal papilla absent, the three sensory cones arising from the membrane of the orbit; head setae sparse or abundant, often fairly long. Labrum broad, bearing setae over much of the disc, the margin somewhat bristly, sometimes with a row of weak sensilla but never with large, barrel-shaped sensilla; epipharynx spinulose, but exhibiting much variation in the abundance and distribution of spinules; mandibles stout and heavy, approximately twice as long as their maximum width, base with a single large seta, inner margin with five teeth or with four teeth one of which is double (rarely with fewer teeth, and in *Palarus* apparently with only two); maxillae rather broad apically, the lacinial area usually projecting as a rounded or angulate lobe apically, the galeae always smaller than the palpi and sometimes extremely small; labium often spinulose above, the spinnerets paired, truncate or pointed, always much exceeding the labial palpi.

### Table of Tribal and Generic Characters

A. Head higher than wide; epipharynx with pigmented sensory areas; mandibles with only two teeth .. PALARINI, *Palarus* [*variegatus*]

AA. Head as wide as, or wider than high; epipharynx with sensory areas unpigmented, often indistinct; mandibles with at least four teeth.

B. Lacinial area of maxilla with, at most, a few elongate papillae (fig. 45); setae unusually long, those on the prothorax, at least, very prominent; longest head setae much longer than the maximum diameter of the antennal orbit and often twice that length ..... MISCOPHINI[2]

C. Anterior lateral angles of epipharynx with an elongate group of large, blunt spinules which are quite unlike those on the remainder of the epipharynx (fig. 44) *Solierella* (*blaisdelli*, sp., [*peckhami, compedita, xambeui*])

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[2] The larvae of only three genera of this tribe are known, and I have seen specimens of only *Solierella*. It is by no means certain that these characters will hold for all genera of this tribe.

CC. Epipharynx without specialized spinules on the anterior lateral angles; galea very small.

D. Inner margin of maxilla prolonged into a sharp point; head setae abundant, more or less evenly distributed.
*Miscophus* [*bicolor*]

DD. Inner margin of maxilla not prolonged as above; head setae sparse, mostly on the top and sides.
*Nitela* [*spinolae*]

BB. Lacinial area of maxilla densely clothed with strong spinules (figs. 12, 24, 38); body setae relatively inconspicuous, except on the thorax of certain genera; head setae short or fairly long, rarely twice as long as the diameter of the antennal orbit ..... LARRINI

C. Epipharynx with a dense covering of unusually strong spinules which converge upon a bare area in the center (fig. 41).

D. Parietal bands weak or absent; thoracic dorsum with numerous strong setae; head setae fairly long, the longest ones about equal to the diameter of the antennal orbit ..... *Motes* [*pompiliformis*]

DD. Parietal bands strong (fig. 39); body setae inconspicuous; head setae short, the longest ones not equal to the diameter of the antennal orbit.
*Liris* (*haemorrhoidalis*)

CC. Epipharynx without unusually long spinules which converge on a bare median area (figs. 15, 23, 37).

D. Prothoracic dorsum with a transverse series of conspicuous setae (figs. 22, 30); head setae long, the longest ones considerably longer than the diameter of the antennal orbit (figs. 21, 33); galeae very small, scarcely rising above the surrounding papillae (figs. 24, 38).

E. Prothoracic lobes conical (fig. 22); apical two teeth of mandibles strong, juxtaposed one above the other (fig. 26); median area of epipharynx bare or with a few papillae or blunt spinules (fig. 23).
*Tachysphex* (*terminatus*, [*costae, lativalvis, nitidus, pectinipes*])

EE. Prothorax with the upper pair of lobes slender, digitiform (fig. 30); penultimate tooth of mandibles small, in the same plane as the ultimate tooth (fig. 32); median area of epipharynx clothed with strong spinules (fig. 37).
*Larropsis* (*distincta*)

DD. Prothoracic dorsum with only minute setae (fig. 10); head setae short, not usually longer than the diameter of the antennal orbit; galeae fairly strong (figs. 12, 19).

E. Pleural lobes of thorax very prominent, conical, the prothorax with three pairs of such lobes (fig. 10); parietal bands short, sometimes very weak (fig. 13).

*Tachytes* (*elongatus, mandibularis*)

EE. Pleural lobes of thorax moderately prominent, not strongly conical, the prothorax apparently with only one pair of lobes; parietal bands long and conspicuous.

*Larra* [*analis, luzonensis*]

## Tribe Larrini

**Tachytes elongatus** Cresson (Plate III, figs. 9-17)

*Body* (diapausing larva).—Length 20 mm.; maximum width (abdominal segment 4) 7 mm. (fig. 9). Relatively stout, cylindrical, abruptly tapered at both ends; each segment with a prominent transverse elevation dorsally, not interrupted medially, extending laterally nearly to the pleural lobes; pleural lobes large, rounded, those on the anterior segments conically protruding, the prothorax with three pairs of such conical lobes (fig. 9, 10); anus distinctly ventral and preapical in position, the anal segment rounded. Integument mostly smooth dorsally, but the venter clothed rather densely with minute spinules; body setae not conspicuous, confined mostly to the thorax (fig. 14). Spiracles with the orifice large, the peritreme narrow, heavily pigmented; walls of the atrium lined with anastomosing ridges which bear short spines; opening into the subatrium armed with a strong circlet of spines; subatrium short and globular (fig. 17).

*Head.*—About as wide as high, measuring about 2.0 mm. each way (fig. 13). Mostly pale, the parietal bands dark, a dark spot at the anterior articulation of the mandibles; mandibles light brown, darker apically; clypeolabral suture brown; hypostomal thickenings, paired spots at the bottom of the occipital foramen, basal portion of maxilla, and line between mentum and prementum of labium dark; palpi, galeae, and spinnerets light brown. Front with a pair of shallow depressions in the middle, and with shallow longitudinal depressions laterad of these, running along the inner side of the antennal orbits; coronal suture weak; parietal bands strong but rather short, only about .28 mm. long, slightly curved; epistomal suture strong. Antennal orbits small, circular, about 70 $\mu$ in diameter, the three sensilla arranged in a triangle (fig. 11). Top and sides of head roughened by many small convexities; head setae sparse, fairly numerous on the lower sides, the longest about 70 $\mu$ in length. Clypeus bearing two irregular transverse rows of small setae.

*Mouthparts.*—Labrum nearly 1 mm. in width; anterior margin shallowly concave medially; disc with about 20 strong setae on the anterior half, these tending to form two irregular transverse rows; anterior margin strongly bristly laterally and with a series of very minute sensory pores (fig. 15). Epipharynx very strongly spinulose, especially latero-apically and medio-basally; sensory areas unpigmented, devoid of spinules, each with five pores. Mandibles 1.05 mm. long, .5 mm. in maximum width; base with a single lateral seta; apex with five teeth, four of them in the same plane, the ultimate and antepenultimate much more distinct than the other two, the fifth tooth blunt and situated ventrally beneath the antepenultimate tooth. Maxilla with a few setae laterally, extensively spinulose on the inner margin, the spinules long and rather flexible; apex papillose; palpi stout, about 130 $\mu$ long; galeae much more slender, about 60 $\mu$ long (fig. 12). Apex of labium broad, with abundant flexible spinules on the oral surface; palpi about 90 $\mu$ in length; spinnerets slender, blunt apically, about 140 $\mu$ in length (fig. 16).

*Material.*—Four larvae, all taken from cocoons, from sand dunes at Antioch, Calif., Sept. 15, 1940 (G. E. Bohart).

**Tachytes mandibularis** Patton (Plate IV, figs. 18-20)

*Body.*—The body of the mature, non-diapausing larva of this species has been figured by Strandtmann (1945, Ann. Ent. Soc. Amer., 38: 306). The single specimen available to me measures 17 mm. in length and agrees fairly well with Strandtmann's figure. The dorsum of each segment is divided into two annulets, with the anterior part of each posterior annulet forming a strong transverse welt; the pleural lobes of the thorax are very prominent and conical, much as figured for *elongatus.* Setae and spinules as described for *elongatus;* spiracles as in that species.

*Head.*—Width 1.9 mm.; height 1.75 mm. In general similar to *elongatus.* Parietal bands very short and virtually unpigmented, therefore scarcely visible. Antennal orbits ovoid, 70 $\mu$ in maximum diameter. Longest head setae about 60 $\mu$ in length. Clypeus with two transverse rows of fairly long setae.

*Mouthparts.*—Labrum .9 mm. wide, its anterior margin very weakly concave medially, bristly laterally; disc with about 35 strong setae (fig. 18). Epipharynx with dense, fairly long spinules except latero-basally; sensory areas not distinct. Mandibles 1 mm. long and .45 mm. in maximum width, as described for *elongatus.* Maxillae with numerous setae laterally, densely papillose apically, lacinial area prominent, clothed with dense spinules; palpi stout, about 100 $\mu$ long; galeae very small, only about 30 $\mu$ long (fig. 19). Labium more or less papillose apically, at the base of each palpus with a group of long, flexible spines; palpi about 100 $\mu$ long; spinnerets slender, the tips blunt, about 200 $\mu$ in length (fig. 20).

*Material.*—One specimen reared from an egg collected by the writer at Blackjack Creek, Pottawatomie Co., Kansas, July 3, 1953.

**Tachysphex terminatus** (Smith) (Plate IV, figs. 21-28)

Since the body of the single available non-diapausing larva is poorly preserved, the following description of the body is drawn from diapausing material. The remainder of the description, however, is drawn from this non-diapausing specimen; the other specimens agree in most details but show much wear of the mandibles and some changes in the spinnerets.

*Body.*—Length 9 mm.; maximum width 2.5 mm. In general similar to *Tachytes elongatus,* but the transverse dorsal elevations and the pleural lobes less prominent; the arrangement of the lobes on the thorax is the same as in Tachytes (fig. 22). Dorsum and pleural lobes of thorax, especially of the prothorax, with numerous large setae; remainder of body with scattered minute setae. Integument smooth dorsally, on parts of the venter clothed with minute spinules. Spiracles with the orifice large, the atrium lined with weak ridges; opening into subatrium simple, unarmed; subatrium long and broad, with a series of irregular transverse folds (fig. 27).

*Head.*—Subcircular in anterior view, measuring 1.1 mm. wide by 1.02 mm. high (fig. 21). Virtually unpigmented except for the anterior tentorial arms, hypostomal thickenings, mandibles, and palpi, which are light brown. Coronal suture short and weak; parietal bands absent. Antennal orbits nearly circular, about 60 $\mu$ in maximum diameter. Head with numerous very prominent setae, the longest ones measuring about 80 $\mu$ in length. Clypeus with numerous strong setae.

*Mouthparts.*—Labrum .44 mm. wide; anterior margin subtruncate; disc with about 12 large setae plus 4 more on the apical margin medially; margin with a series of minute sensilla, only very weakly bristly on the lateral angles (fig. 23). Epipharynx with strong bristles laterally and along the apical margin, those on the median area directed inward; remainder of epipharynx more or less bare except for a few weak sensory cones and a few spinules at the extreme base. Mandibles .52 mm. long and .26 mm. in maximum width; base with a single lateral seta; apex with five teeth, the apical two juxtaposed in such a way that the apex is strongly bifid in lateral view, one of the remaining teeth located beneath the other two (fig. 26). Maxillae papillose apically, laterally with strong setae; lacinial area somewhat protruding and with dense, erect spinules; palpi stout, about 70 $\mu$ in length; galeae small, only about 20 $\mu$ in length (fig. 24). Oral surface of labium papillose, some of the papillae grading into short spinules apically; palpi slender, about 80 $\mu$ in length; spinnerets slender, about twice the length of the palpi (fig. 25).

*Material.*—One specimen from Blackjack Creek, Pottawatomie Co., Kansas, Aug. 4, 1952 (H. E. Evans); two specimens from cocoons, Logan, Utah, Aug. 1953 (G. E. Bohart).

**Tachysphex costae** (Destefani)
**Tachysphex lativalvis** (Thomson)
**Tachysphex nitidus** (Spinola)
**Tachysphex pectinipes** (Linnaeus)

The larvae of these Palaearctic species have all been described and figured in considerable detail by Grandi (1928, Boll. Lab. Ent. Bologna, 1: 295-308; 1930, ibid., 3: 326-330; 1934, ibid., 7: 59-61). In every case the body form is very similar to that of *terminatus*, and as in that species there are prominent setae on the thoracic dorsum. The parietal bands are lacking in all four, and the antennal orbits are small and circular. There are minor specific differences in the characters of the labrum and epipharynx, but in general they do not depart notably from the condition in *terminatus*; the apical margin of the labrum varies from barely to quite strongly bristly; the median portion of the epipharynx is devoid of spinules in *nitidus* and *pectinipes*, but bears a few blunt spinules or papillae in the other two. The mandibles are without exception as described for *terminatus*. The maxillae are strongly papillose apically in all four species and the galeae are in every case very small; the lacinial area, at least so far as described, is spinulose and slightly protruding as in *terminatus*. The spinnerets are in every case approximately twice the length of the labial palpi.

**Larropsis distincta** (Smith) (Plate V, figs. 29-38)

*Body.*—Length 13 mm.; maximum width 4 mm. (fig. 29). Anus situated ventrally well before the tip of the abdomen and with distinctly raised lips. Abdominal segments with the posterior annulets elevated to form transverse welts which laterally are nearly continuous with the pleural lobes. Thoracic pleural lobes conically protuberant, the prothorax with three pairs of lobes, as in *Tachytes* and *Tachysphex*, the lobes unusually slender, the dorsal pair digitiform (figs. 29, 30). Prothoracic dorsum with a transverse band of prominent, dark setae; other body segments with a few weak setae dorsally. Integument in large part covered with small spinules which are removed from one another by approximately their own length (fig. 31); these spinules occur ventrally and extend more or less up the sides, but are

mostly absent dorsally. Spiracles with the atrium lined with fine ridges which tend to form elongate cells; subatrium elongate, narrowing gradually to the trachea; opening into subatrium small, simple (fig. 34).

*Head.*—Width 1.19 mm.; height 1.06 mm. (fig. 33). Coronal suture weak; parietal bands absent. Antennal orbits transversely elliptical, very small, measuring about $35 \times 42$ $\mu$ (fig. 35). Setae strong, the longest ones measuring about 65 $\mu$. Clypeus with a single row of strong setae.

*Mouthparts.*—Labrum .54 mm. wide, the apical margin rounded, barely emarginate medially (fig. 37); disc with about 18 large setae, also with about 12 small sensilla toward the apical margin, which is strongly bristly. Epipharynx strongly spinulose except for a bare area on each side; several sensory pores are located in each bare area. Mandibles .65 mm. long, .32 mm. wide at the base; base with a single seta; inner margin with five teeth, the penultimate tooth weak and in the same plane as the apical tooth, the basal three teeth in a close group, one beneath the other two (fig. 32). Maxillae broad apically, strongly papillose, the lacinial area somewhat produced and strongly spinulose; palpi small, only about 60 $\mu$ long and nearly as wide; galeae minute, only about 20 $\mu$ long (fig. 38). Labium strongly spinulose on the oral surface; palpi about 50 $\mu$ long; spinnerets long, truncate apically, measuring about 110 $\mu$ from the base.

*Material.*—Two specimens from sandpit at Six-mile Creek, Ithaca, N.Y., Sept. 1957 (H. E. Evans).

**Motes pompiliformis** (Panzer)

Grandi (1928, Boll. Lab. Ent. Bologna, 1: 292-295) has described the larva of this Palaearctic species in considerable detail. The general form is similar to *Tachysphex*; as in that genus the thoracic segments bear strong setae dorsally and laterally, while the abdominal segments are weakly setose; the pleural lobes are apparently rounded on all segments, not conically produced, and the prothorax has but a single pair of lobes. The head shape is about as in *Tachysphex;* parietal bands are absent; the antennal orbits are small and circular; head setae are abundant but not especially long, the longest ones being about as long as the width of the antennal orbits. The labrum is large, convex apically; the disc bears numerous setae and the margin is bristly; the epipharynx has a dense covering of unusually long spinules which tend to converge toward a small, bare area in the middle. The mandibles have five sharp teeth, the apical two somewhat juxtaposed, much as in *Tachysphex.* The maxillae are papillose apically, the lacinial area with dense spinules, the galeae about

half the size of the palpi. The spinnerets are about twice the length of the labial palpi.

**Liris haemorrhoidalis magnifica** (Kohl) (Plate VI, figs. 39-41)

Williams (1928, Bull. Hawaiian Sug. Pl. Assoc., Ent. Ser., no. 19, pp. 49-53) presented notes on the biology of this wasp and a brief discussion of the larva. He states that the full-grown larva "measures 22 millimeters and as in related genera bears conspicuous lateral processes on the thorax". His sketch shows conical pleural lobes somewhat as in *Tachytes*. The slide which Williams made of the head capsule has been loaned to me and the following description is drawn from it.

*Head.*—Width 2.2 mm.; height 2.0 mm. (fig. 39). General features and pigmentation much as in *Tachytes;* parietal bands strong, about .5 mm. in length. Antennal orbits small, circular, 100 $\mu$ in diameter. Top and sides of head weakly roughened by small convexities; setae sparse and small, the longest ones about 80 $\mu$ in length. Epistomal suture strong; clypeus with a few rather strong setae.

*Mouthparts.*—Labrum about 1 mm. in width (fig. 41); apical margin convexly rounded, somewhat bristly, without noticeable sensilla; disc with numerous strong setae; epipharynx densely spinulose, the median apical spinules directed inward, and in fact all the spinules converging on a small median bare area, as shown in fig. 41 and very much as figured by Grandi for *Motes pompiliformis*. Mandibles 1 mm. long by .5 mm. in maximum width; outer margin sinuate about midway; apex with four teeth, the apical two in the same plane, the basal two more ventral in position; ventral surface of mandible excavated between the first and third teeth (fig. 40). Details of maxillae and labium, so far as visible in the preparation, not differing notably from *Tachytes;* galeae much smaller than the maxillary palpi; lacinial area spinulose, somewhat protruding; labial palpi about 100 $\mu$ long; spinnerets blunt, about 140 $\mu$ long.

*Material.*—A single balsam mount of a head capsule, made by F. X. Williams, specimen from No. Queensland, Australia, 1919.

**Larra analis** Fabricius (Plate VII, figs. 58, 59)

The larva of this North American species has been described by Cushman (1935, Proc. Ent. Soc. Wash., 37: 82-87). The body is said to be 20 mm. long, fusiform, slightly more swollen posteriorly; the anus is ventral and preapical, the lips of the anus somewhat protuberant, as in *Larropsis*. The pleural lobes are rounded, those on the thorax apparently not conically produced as in most

Larrinae; however, Cushman does state that " the thoracic pleura and the prosternum protrude beyond the general surface of the body ". No mention is made of setae on the body or head. The head is slightly broader than high; parietal bands are long and conspicuous; the antennal orbits are small and circular. The labrum is large, the margin convex, bristly; the epipharynx is wholly clothed with spinules. The maxillary palpi are somewhat longer than the galeae and the lacinial area is strongly spinulose and slightly protuberant; the spinnerets are about twice as long as the labial palpi.

Cushman's description is based on material collected by C. E. Smith in connection with his biological studies of this species (1935, ibid., pp. 65-82). I have been unable to find the specimens which Cushman worked with, but there are two cocoons collected by Smith in the U. S. National Museum. From one of these cocoons I was able to extract the remains of the larval head capsule, but this was in poor condition except for the mandibles. The mandibles have four teeth, but the third tooth is broad and emarginate so that it presents the appearance of two teeth (figs. 58, 59); the mandibles measure .9 mm. in length by .4 mm. in maximum width. The antennal orbits are circular, 100 $\mu$ in diameter, with the three sensilla in a triangle in the center. A very few setigerous punctures are present on the lower sides of the head; the longest setae measure about 50 $\mu$.

**Larra luzonensis** Rohwer

Williams (1919, Bull. Hawaiian Sug. Pl. Assoc., Ent. Ser., no. 14, p. 134) states that the larva of this species has the pleural lobes well marked and " as usual in Larrids, tuberculate on the thorax. On the middle of the underside of the twelfth segment is a small, rather low tubercle." In the figure published later (1928, ibid., no. 19, p. 43) he shows prominent lobes on the thorax, but these are scarcely as pointed as in *Tachytes*, and there are no extra lobes on the prothorax.

## Tribe Palarini

**Palarus variegatus** (Fabricius)

The larva of this species has recently been described and figured by Grandi (1954, Boll. Ist. Ent. Univ. Bologna, 20: 174-177). The body form is not dissimilar to that of *Tachytes*, but the thoracic pleural lobes are simple and rounded. The body is without conspicuous setae and those on the head are numerous but very small. The head is considerably higher than wide, parietal bands are absent, and the antennae are much as in the Larrini. The labrum bears numerous setae and the margin is bristly; the epipharynx is complex in structure and bears, among other things, a pair of pigmented sensory areas each bearing several small sensilla. The mandibles have a single lateral seta and terminate in only two distinct teeth. The maxillary palpi are large, the galeae very minute and scarcely visible above the papillae. The spinnerets are about twice the length of the labial palpi.

## Tribe Miscophini

**Solierella blaisdelli** (Bridwell) (Plate VI, fig. 42)

*Body.*—Length about 4 mm.; grub-like, relatively short and stout (fig. 42). Each segment divided dorsally into two annulets, of which the posterior is the more prominent; anus distinctly preapical in position, the anal segment forming a rounded lobe; pleural lobes prominent, rounded, those on the thorax somewhat more produced than the others, the prothorax with two extra pairs of small lobes, as illustrated. Prothorax with numerous setae dorsally and laterally, the remaining body segments only very sparsely setose. Integument smooth, except slightly roughened by small spinules on parts of the venter. Spiracles small and unpigmented; walls of the atrium lined with weak ridges; opening into subatrium small, unarmed; subatrium long and slender.

*Head.*—Width .83 mm.; height .66 mm. General features about as described and figured for the following species, but the parietal bands not visible. Antennal orbits 40 $\mu$ in diameter. Setae sparse but large, the longest about 50 $\mu$ in length.

*Mouthparts.*—Labrum .32 mm. wide, its anterior margin broadly truncate; disc with 10 large setae and apical margin with a group of six setae medially; epipharynx spinulose apically and laterally, the antero-lateral angles with numerous rather stout, blunt spines. Mandibles badly worn, presumably similar to those of the following species. Maxillary palpi about 50 $\mu$ long; galeae slender, about 40 $\mu$ long; lacinial area somewhat produced, weakly spinulose. Labial palpi 40 $\mu$ long; spinnerets blunt, about 1.5 times the length of the labial palpi.

*Material.*—A single specimen taken from a cocoon, Putah Canyon, Calif., Dec. 18, 1939 (G. E. Bohart).

**Solierella** sp. (Plate VI, figs. 43-45)

*Body.*—Length about 4 mm.; maximum width about 1 mm. Each body segment with a very prominent transverse dorsal elevation which is interrupted medially; pleural lobes strong, conically protuberant, especially so toward the two ends of the body. Prothorax with a band of very strong, conspicuous setae on the dorsum and pleural lobes; other thoracic segments with somewhat fewer setae, the abdominal segments not noticeably setose. Integument and spiracles as described for *blaisdelli.*

*Head.*—Subcircular in anterior view; maximum width .73 mm.; height .63 mm. (fig. 43). Pale, the mandibles light brown, the anterior tentorial arms and hypostomal thickenings dark brown. Coronal suture very short; parietal bands present but very weak; antennal orbits small, about 35 $\mu$ in diameter. Setae few in number but unusually long, the longest ones about 70 $\mu$ in length; clypeus also with a few long setae.

*Mouthparts.*—Labrum .3 mm. wide, its anterior margin weakly concave medially; disc with about 10 very large setae, two of which are set in the margin medially; margin with a series of about 10 very small, nipple-like sensilla, somewhat spinulose laterally (fig. 44). Epipharynx with large, broad spinules basally and laterally; sensory areas each containing a few setiform sensilla; antero-lateral angles each with a transverse series of large, blunt spines. Mandibles .33 mm. long and .19 mm. wide at the base; base with a single lateral seta; apex with four large teeth, the apical two juxtaposed one above the other, also with a small fifth tooth located beneath the most basal tooth. Maxillae setose laterally, more or less papillose apically; lacinial area somewhat protuberant, with a few weak, blunt spinules; palpi stout, about 50 $\mu$ long; galeae also stout, about 30 $\mu$ long (fig. 45). Labial palpi about 40 $\mu$ long; spinnerets about twice that length, blunt apically.

*Material.*—Eight specimens, all diapausing, from Sacramento, Calif., March 1947 (G. E. Bohart).

**Solierella peckhami** (Ashmead)

Williams (1926, Proc. Hawaiian Ent. Soc., 6: 443) has presented sketches of the full-grown larva of this species (under the name *rohweri* Bridwell). The posterior end of the body is truncate; the pleural lobes are prominent, those on the thorax especially so, although not pointed; body setae are long and conspicuous, especially on the thoracic dorsum. I have been able to borrow a slide which Williams made of the head capsule, but unfortunately many of the details are not visible on this preparation. The form of the head is much as in the preceding species,

and the setae are also very long (maximum length 40 $\mu$). The mandibles have five teeth, arranged as in the preceding species, but all very much sharper. The rest of the mouthparts cannot be seen clearly on the slide.

**Solierella compedita** (Piccioli)

The larva of this European species has been described by Soika (1934, Ann. Soc. Ent. France, 103: 342). The body shows the transverse dorsal elevations and strong pleural lobes described for *blaisdelli*; there appear to be additional lobes on the prothorax as in that species. Body setae are not mentioned or figured. The head is much as in figure 43, including the sparse but long setae. The labrum has several long setae; the epipharynx is more or less bare except for some short basal spinules, a few sensilla, and a transverse row of large, blunt spines on each side of the apical margin. The maxillary palpi and galeae are stout, the latter somewhat shorter than the former. The spinnerets are very slender, only a little longer than the labial palpi.

**Solierella xambeui** (André)

The larva of this Palaearctic species has been described by Micheli (1937, Atti Soc. Ital. Sci. Nat. Milano, 76: 287-290). Body setae are not mentioned or figured, but the head setae are sparse and rather long as in the preceding several species. The labrum is truncate apically and bears eight large setae plus some marginal, nipple-like sensilla. The epipharynx has a few basal spinules but is otherwise devoid of spines except for two large groups of long, blunt spines on the outer apical angles. The mandibles are hollowed out ventrally and are shown as having four teeth. The maxillary palpi are nearly twice as long as the galeae, the spinnerets about 1.5 times as long as the labial palpi.

**Miscophus bicolor** Jurine

Maneval (1939, Ann. Soc. Ent. France, 108: 72-74) has presented a description of the larva of this European species. The body is said to be 4 mm. long and to bear pale erect setae which are shorter and sparser ventrally. The head is broader than high and bears long setae distributed rather evenly over its entire surface. The antennal orbits are small and much as in *Solierella*. The labrum is truncate apically and bears numerous large setae

plus some short setae or setiform sensilla near the apical margin. The mandibles are five-toothed and as described for *Solierella*. The maxillae are wholly papillose apically, the lacinial area with a pointed apical projection; the galeae are very short, hardly longer than broad. The labium is finely papillose, the spinnerets long and pointed, about twice as long as the labial palpi.

**Nitela spinolae** Latreille

The larva of this species has recently been described very briefly by Valkeila (1955, Ann. Ent. Fennici, 21: 54-56). The pleural lobes are distinct; the prothorax has numerous rather conspicuous brown setae dorsally, the remaining body segments one row of such setae. The head is broader than high and has a row of large brown setae on the top and sides; the mandibles have five teeth, four on the " frontal edge " and one on the " inner edge ". The maxillary palpi and galeae are both small, " nodule-like ", the latter smaller than the former. The salivary opening is said to be transverse, but " in the rear two small openings of the salivary tubules are to be seen ". Valkeila's description was drawn from an overwintering larva, and it may be that the spinnerets had undergone some deterioration.

## Subfamily Pemphredoninae

The larvae of this subfamily which are before me are remarkably uniform in structure. They appear to be about as close to the Sphecinae as to any other group: the apical margin of the labrum usually has a thickened and often pigmented band, as in the Sphecini; the spinnerets are paired but often connected by a membrane, a condition approaching the broad, slit-like spinneret of the Sphecinae; antennal papillae are absent (except, according to Maneval, in *Ammoplanus*); and the mandibles are not dissimilar to those of the Sphecini.

The Pseninae, often regarded as a tribe of Pemphredoninae, have very different larvae, and will be treated in a subsequent section as a separate subfamily.

*Characters of the subfamily.*—Body elongate-fusiform, the dorsal profile often slightly serrate, the pleural lobes rounded, not especially strong; anus terminal, inconspicuous; integument smooth or with small spinules, with or without noticeable short

setae; spiracles with the peritreme distinct, rather large, the atrium globular, its walls not spined or otherwise modified, the opening into the subatrium simple, unarmed, the subatrium elongate, separated from the trachea by a constriction. Head wider than high; parietal bands absent; head setae very small, usually very sparse; antennal orbits relatively large, the three sensilla arising directly from the membrane of the orbit, which may be slightly elevated (but in *Ammoplanus* a distinct papilla is said to be present). Labrum very broad, usually strongly emarginate, the disc with only a few weak setae and a few small sensilla; apical margin not at all bristly, usually with a narrow marginal band which is sometimes pigmented; median line and basal marginal also sometimes pigmented; epipharynx mostly bare, with a few peg-like sensilla toward the median line and often with a few weak spinules laterally. Mandibles broad and short, considerably less than twice as long as broad, with a single seta laterally near the base, apically with four teeth in somewhat the same plane but tending to surround a slight ventral concavity; maxillae short and directed mesad, the lacinial area reduced and at most with a few weak, blunt spinules; maxillary palpi fairly strong, the galeae smaller and sometimes very weak or even (in *Ammoplanus*) apparently absent; apex of labium without papillae or spinules, the spinnerets relatively short, blunt or acute, often connected by a membrane.

## Table of Generic Characters [3]

A. Antennal papilla present; body and head rather evenly clothed with small setae; labrum not emarginate; galeae absent (or perhaps very small and not readily visible) ..... *Ammoplanus* [*perrisi*]

AA. Antennal papilla absent, the sensilla arising directly from the membrane of the orbit; head and body setae very sparse; labrum emarginate apically; galeae well developed.

B. Integument spinulose at least antero-ventrally (figs. 51, 62); apical margin of labrum (at least usually) with a pigmented band (figs. 53, 64); setae on head and labrum fairly prominent; spiracular subatrium moderately broad (fig. 52).

[3] Includes five of the ten Nearctic genera, one of them known from published description only. The larvae of four of these genera are exceedingly similar, and the characters presented here may prove partly or wholly invalid when more species have been described.

C. Integument of body rather evenly spinulose anteriorly, including the thoracic dorsum; epipharynx not or very weakly spinulose (fig. 64).
*Passaloecus* (*mandibularis*, [*brevicornis, tenuis*])

CC. Integument spinulose only on parts of the sides and on the venter; epipharynx spinulose on the sides (fig. 53)
*Pemphredon* (*tenax, giffardi, concolor*, [*rugifer, lugubris*[4]])

BB. Integument apparently entirely without spinules; apical margin of labrum (at least usually) not pigmented (figs. 66, 68); setae on head and labrum very small; spiracular subatrium very slender (fig. 65).

C. Body generally larger and more fusiform, with a few inconspicuous setae; maxilla slightly roughened by small papillae or spinules (fig. 67); spinnerets usually acute apically.
*Xylocelia* (*franclemonti, virginiana*, [*minuta, tristis*])

CC. Body generally smaller and more cylindrical; maxilla smooth (fig. 69); spinnerets often blunt apically.
*Stigmus* (*inordinatus*, [*pendulus*])

**Pemphredon (Cemonus) tenax** Fox (Plate VII, figs. 49-55)

*Body.*—Length 8 mm.; maximum width (abdominal segment 3) 2 mm. (fig. 49). Fusiform-cylindrical; anterior portion of each posterior annulet raised to form a transverse elevation which is interrupted medially; pleural lobes present but small, rounded, those on the prothorax somewhat larger and lower than the others; anus terminal, the supra-anal lobe slightly more prominent than the subanal. Integument smooth and without conspicuous setae or spines; however, under high magnification some small spinules are apparent on some parts of the body, mostly antero-ventrally, as well as some minute setae (fig. 51). Spiracles as shown in figure 52, with the subatrium rather long and nearly as broad as the atrium, constricted for a distance before joining the trachea.

*Head.*—Wider than high; width .83 mm.; height .64 mm. (fig. 50). Pale and unpigmented except for certain parts which are dark brown; these are: anterior tentorial arms, entire margin of labrum plus a median longitudinal band, mandibles, margin and subapical ring on the maxilla, a circular ring surrounding the base of the prementum, and the palpi and galeae. Coronal suture and parietal bands not visible; epistomal suture barely defined, straight. Antennal orbits large, circular, 60 $\mu$ in diameter, the three sensilla forming a triangle in the center of the orbit. Head setae sparse and small, the longest ones only about 15 $\mu$ in length; clypeus with fairly numerous very small setae.

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[4] However, the larva of *lugubris*, as described by Grandi, differs in several characters from the other species and will by no means fit here. For further discussion, see under that species in text.

*Mouthparts.*—Labrum .3 mm. wide, .12 mm. in maximum height, thus about 2.5 times as broad as high (fig. 53). Entire margin of labrum, basal, lateral, and apical, with a pigmented band, the median line also with a pigmented band from base to apex; the outer marginal band appears somewhat striate because of small sensilla set within it; disc with 12 setae set back somewhat from the margin, also with a few small sensilla. Epipharynx apparently bare for the most part, but with a small group of conical sensilla on each side of the median line and a few weak spinules laterally. Mandibles .27 mm. long, .16 mm. wide at the base; base with a single seta laterally; apex with four large teeth, all in somewhat the same plane but tending to surround a slight ventral concavity, the apical two more or less one above the other (fig. 54, ventral view). Maxilla turned somewhat mesad apically, the lacinial area short, not noticeably spinulose; palpi stout, about 45 $\mu$ long; galeae much more slender, about 38 $\mu$ long. Labium smooth and rounded apically, without noticeable spines or papillae but with a few setae; palpi about 30 $\mu$ in length; spinnerets rather broad and blunt, connected by a membrane, exceeding the palpi only slightly (fig. 55).

*Material.*—Eight specimens taken from a nest in a rotten poplar log, Ithaca. N.Y., Aug.-Sept. 1956 (H. E. Evans).

**Pemphredon (Cemonus) giffardi** (Rohwer) (Plate VII, fig. 57)

*Body.*—About 9 mm. long, resembling that of *P. tenax* in all details. The spiracles are similar in structure and the integument is similarly smooth except for a few areas of minute spinules.

*Head.*—Width .95 mm.; height .76 mm. Antennal orbits circular, 70 $\mu$ in diameter. Setae sparse and short, as in *tenax*, the top of the head a little more roughened by small convexities than in that species.

*Mouthparts.*—Labrum .39 mm. wide, .15 mm. in median height, .17 mm. in maximum height, thus only about 2.3 times as broad as high (fig. 57); disc with a row of 12 setae toward the apical margin, but without sensilla except for a series of small ones set in the apical band near the median line. Mandibles as described for *tenax*, and the maxillae and labium very much as in that species; the lacinial area is very slightly roughened but not actually spinulose or papillose.

*Material.*—One specimen from Putah Canyon, Calif., from nest in stem of tree of heaven (G. E. Bohart).

**Pemphredon (Cemonus) inornatus** Say

Packard (1896, Jour. N.Y. Ent. Soc., 4: 159-160) presented a brief description of the larva of this species, but his description is not meaningful in the present context. He does state that in the "middle of the body the dorsal arches of the segments are

thickened suddenly so as to give a serrate outline to the back when seen in profile" and the "labrum is nearly three times as broad as long, slightly bilobate". Doubtless the larva of this species will be found to resemble closely that of the preceding two species.

**Pemphredon (Cemonus) rugifer** (Dahlbom)

Grandi (1929, Boll. Lab. Ent. Bologna, 2: 274-277) has described the larva of this European species( under the name *unicolor* Fabricius). The body form is exactly as in *tenax,* including the enlarged pleural lobe on the prothorax. Head setae are small, parietal bands are absent, and the antennal orbits are large and circular. The labrum is shaped much as in *tenax* and has a similar median pigmented band; however, Grandi makes no mention of the apical margin also being pigmented. The features of the labrum and epipharynx are very much as in *tenax,* the latter being mostly bare except for a few sensilla and a few lateral spinules. The maxillae and labium are exactly as described for *tenax,* and the spinnerets, as in that species, have a broad basal connection between them.

Micheli also described the larva of this species a year later than Grandi (1930, Mem. Soc. Ent. Italiana, 9: 61-64). His description agrees closely with that of Grandi but he does indicate a pigmented band along the apical margin of the labrum.

**Pemphredon (Pemphredon) concolor** Say (Plate VII, fig. 56)

This description is based on a single cast skin taken from a cocoon.

*Body.*—Integument mostly smooth, but in certain areas with fairly dense, minute spinules. Spiracles much as figured for *tenax* except that the subatrium is even more broadly swollen and just as wide as the atrium.

*Head.*—Antennal orbits circular, 60 $\mu$ in diameter, the three sensilla forming a triangle in the orbit. Lower sides of the head and also the clypeus with numerous very short setae, the longest ones about 25 $\mu$ in length.

*Mouthparts.*—Labrum .43 mm. wide, .16 mm. in maximum height; disc with a row of about 12 setae plus numerous additional punctures basad of these; margin with a row of minute sensory pores; median band and entire margin pigmented. Mandibles .3 mm. long, .22 mm. wide at the base, the apex with four teeth in about the same plane, the two middle teeth the strongest. Maxillary palpi slightly longer and thicker than the galeae;

lacinial area only slightly roughened. Spinnerets arising from a broad base, not exceeding the labial palpi (fig. 56).

*Material.*—Exuviae taken from a cocoon from which an adult had emerged; specimen from rotten log, Four Mile Run, Arlington, Va., May 1957 (J. G. Rozen) [U. S. Nat. Mus.].

**Pemphredon (Pemphredon) lugubris** (Fabricius)

The larva of this species, the type of the genus and subgenus, has been described by Grandi (1929, Boll. Lab. Ent. Bologna, 2: 271-274). I find Grandi's description puzzling; in certain features the larva agrees well with *concolor*, but in several important characters it is very different. The body is relatively short and thick, but otherwise not dissimilar to that of *concolor*. However, a distinct antennal papilla is present, the labrum bears several very large apical sensory cones and is without a pigmented border or median band, and the epipharynx is almost wholly covered with spinules. The mandibles and maxillae are shaped much as in *concolor* but the latter structures are papillose apically. The spinnerets are not described or figured.

The differences between *lugubris* and *concolor* are difficult to explain; certainly the adults of the two species appear to differ only in minor characters. The larva of *concolor* closely resembles that of several species of the subgenus *Cemonus*. Grandi's failure to provide descriptions and figures of the whole head capsule and of the spinnerets suggests that his material may have been deficient in certain respects. It is also, possible, of course, that his larvae were misidentified.

**Passaloecus mandibularis** (Cresson) (Plate VIII, figs. 60-64)

*Body.*—Length 7 mm.; maximum width 1.7 mm. (fig. 60). Fusiform and in general similar to *Pemphredon tenax;* pleural lobes rounded, fairly prominent; each abdominal segment except the last two with a pair of strong transverse swellings dorso-laterally; supra-anal lobe more prominent than subanal. Integument, at least anteriorly, clothed rather uniformly with small spinules which for the most part are separated by more than their own length, also with a few small, scattered setae (fig. 62). Spiracles similar to those of *Pemphredon tenax*.

*Head.*—Width .6 mm.; height .56 mm.; subcircular in anterior view; coronal suture fairly strong; parietal bands absent (fig. 61). Antennal orbits subcircular, 40 $\mu$ in diameter, the three sensilla forming a triangle in the center of the orbit. Setae sparse, fairly strong, the longest about 30 $\mu$ in length.

*Mouthparts.*—Labrum .24 mm. wide, .09 mm. high; apical margin somewhat emarginate; disc with about 12 strong setae, all near the anterior margin, plus several sensilla on or near the margin toward the median line; entire margin rather weakly pigmented, the median line with a prominent dark median band which, however, does not reach the base of the labrum (fig. 64). Epipharynx virtually bare except for twelve peg-like sensilla which are arranged in four groups of three each. Mandibles .2 mm. long, .13 mm. in maximum width; base with a single seta; apex with four teeth exactly as figured for *Pemphredon tenax* (fig. 54). Maxillae much as in *Pemphredon,* the lacinial area short and nearly smooth; palpi and galeae both about 35 $\mu$ long, the galeae slightly more slender. Labial palpi 30 $\mu$ long, the spinnerets broad, exceeding the palpi only slightly, connected by a membrane.

*Material.*—Three specimens from Ithaca, N.Y., July 1956 (H. E. Evans). Two specimens from Rochester, N.Y., Sept. 1953 (K. W. Cooper) [U.S. Nat. Mus.], determined as *Passaloecus* ? by K. V. Krombein, agree closely and may represent this same species.

**Passaloecus brevicornis** Morawitz

Grandi (1934, Boll. Lab. Ent. Bologna, 7: 42-46) presented a very detailed description of the larva of this Palaearctic species. The body form is much as in *mandibularis*, but the supra-anal lobe is rounded and only slightly more protuberant than the subanal. The thoracic segments are clothed with small spinules, as in *mandibularis*; there are a few small setae on all the body segments. Features of the head are very much the same as in *mandibularis*. The labrum is weakly emarginate apically and has a complete pigmented median band; the apical margin bears some conical sensilla but is not notably thickened or pigmented. The epipharynx is virtually bare except for four groups of peg-like sensilla as in *mandibularis*. The mandibles are 4-toothed and have a single seta at the base. The maxillae are about as described for *mandibularis*, but the galeae are shorter than the palpi. The spinnerets are broad and connected by a membrane.

**Passaloecus tenuis** Morawitz

According to Grandi (1934, ibid., pp. 47-48) the larva of this species is very similar to that of *brevicornis*. He figures the head, labrum, and mandibles, and they seem to differ scarcely at all from those of *brevicornis*.

**Xylocelia franclemonti** Krombein (Plate VIII, figs. 65, 66)

*Body.*—Length 7 mm.; maximum width 1.8 mm. Fusiform and in general much like that of *Pemphredon tenax;* each body segment except the first and last two with a pair of transverse dorsal elevations; pleural lobes rather weak, those on the prothorax situated rather low; anus terminal, the supra-anal and subanal lobes about equally prominent. Integument smooth and without noticeable spinules, but with a few small setae on the top and sides of the thorax. Spiracles about as in *Pemphredon tenax* except the subatrium relatively more slender (fig. 65).

*Head.*—Width .8 mm.; height .63 mm. Very much as described and figured for *Pemphredon tenax.* Antennal orbits large, circular, 60 $\mu$ in diameter, the three sensilla forming a triangle in the center of the orbit. Setae small and inconspicuous, the longest ones only 20 $\mu$ in length. There appear to be only about 30 setigerous punctures on the head capsule and about 16 more on the clypeus.

*Mouthparts.*—Labrum .32 mm. wide, .12 mm. in maximum height, with a weak apical emargination (fig. 66); disc with numerous punctures on the apical half, some of them bearing very short setae; median band complete, strongly pigmented; apex, sides, and base showing some evidence of a marginal band which, however, is not or scarcely pigmented. Epipharynx only weakly spinulose on the anterior lateral angles; sensory pegs prominent, six on each side in an oblique row. Mandibles .27 mm. long, .16 mm. wide at the base, exactly as described for *Pemphredon tenax.* Maxillae with several lateral setae; lacinial area short, somewhat roughened by small spinules; palpi stout, 40 $\mu$ in length; galeae slightly shorter and more slender. Labium with a few setae ventrally, the oral surface bare; palpi short and stout, 25 $\mu$ long; spinnerets prominent, acute apically, about 50 $\mu$ in length.

*Material.*—Three specimens from a sand bank, East Ithaca, N.Y., Aug. 11, 1956 (H. E. Evans).

**Xylocelia virginiana** Rohwer (Plate VIII, fig. 67)

*Body.*—Length 6 mm.; in every respect as described for *franclemonti.*

*Head.*—Width .82 mm.; height .65 mm. Antennal orbits 55 $\mu$ in diameter. Setae small and sparse, the longest ones about 20 $\mu$ in length.

*Mouthparts.*—Labrum .32 mm. wide, .13 mm. in maximum height; setae on the disc slightly larger than in *franclemonti;* sensory pegs of the epipharynx slightly farther removed from the apical margin than in that species. Mandibles virtually the same as figured for *Pemphredon tenax.* Maxillary palpi short and stout, about 30 $\mu$ long and nearly as wide; galeae much more slender but nearly as long. Labial palpi about 30 $\mu$ long; spinnerets tapering to an acute apex, about 50 $\mu$ long (fig. 67).

*Material.*—One specimen from Plummer's Island, Md., June 15, 1957 (K. V. Krombein).

**Xylocelia** spp.

Single, poorly preserved larvae of two other species of *Xylocelia,* with associated adults, are before me, but in both cases the species cannot be identified until a modern revision of this genus is available. These larvae are so similar to the two species described above that it seems unnecessary to describe them in detail. In both cases the labrum has a median pigmented band but the apical margin is unpigmented; in both cases the spinnerets taper to an acute apex and much exceed the labial palpi. The characters of the epipharynx, mandibles, and maxillae show no noteworthy differences from the preceding two species.

*Material.*—One specimen from Pottawatomie Co., Kansas, June 12, 1952 (H. E. Evans); one specimen from Logan, Utah, June 15, 1954 (G. E. Bohart).

**Xylocelia minuta** (Fabricius)

Grandi (1934, Boll. Lab. Ent. Bologna, 7: 50-52) has provided an excellent description of the larva of this European species. It appears to resemble the American species very closely. The labrum has a transverse pigmented band at the base and a longitudinal median pigmented band; the apical margin is unpigmented but has a few small sensilla near the median emargination. The apex of the maxilla is papillose, the palpi longer and thicker than the galeae. The major difference from the known American species seems to be in the spinnerets, which are much longer than the labial palpi, truncate apically, and connected by a membrane as in *Pemphredon.*

**Xylocelia tristis** (Van der Linden)

Maneval (1939, Ann. Soc. Ent. France, 109: 74-75) has described the larva of this species briefly. He reports that it resembles that of *minuta* very closely, differing chiefly in the more weakly dentate mandibles. Maneval's figure of the labium shows the spinnerets as being somewhat acute apically rather than truncate as in *minuta.*

**Stigmus inordinatus** Fox (Plate VIII, figs. 68, 69)

*Body.*—Length 4.5 mm.; maximum width about 1 mm. Form much as in *Pemphredon tenax,* but slightly more slender and cylindrical; supra-

anal lobe extending slightly beyond the subanal. Integument smooth, without spines or setae. Spiracles much as figured for *Xylocelia* (fig. 65), with the subatrium rather slender.

*Head.*—Width .5 mm.; height .43 mm. Virtually unpigmented; parietal bands absent; epistomal suture distinct. Antennal orbits circular, 40 $\mu$ in diameter, the three sensilla located on a somewhat dome-like elevation of the membrane of the orbit. A few setae are present below and to the sides of the orbits; these are very minute, the longest about 15 $\mu$ in length.

*Mouthparts.*—Labrum .22 mm. wide, .08 mm. in maximum height, thus over 2.5 times as broad as high; apical margin strongly emarginate; margin and median line unpigmented; disc with a few weak setae and sensory cones on the apical half (fig. 68). Epipharynx bare except for about four sensory cones on each side. Mandibles .18 mm. long, .11 mm. wide at the base, exactly as described for *Pemphredon tenax*. Maxillae smooth apically; palpi stout, about 25 $\mu$ long, the galeae somewhat smaller. Labium also smooth apically; palpi short and stout, only about 15 $\mu$ long; spinnerets truncate apically, slightly exceeding the palpi (fig. 69).

*Material.*—One specimen from elderberry stem, Logan Canyon, Utah, June 1944 (G. E. Bohart).

**Stigmus fraternus** Say

Packard (1896, Jour. N.Y. Ent. Soc., 4: 158-159) presented a few notes on the larva of this species. The labrum is said to be bilobate and with a distinct median line, presumably darkly colored. Other than this, there is nothing significant in his description.

**Stigmus pendulus** Panzer

Maneval (1939, Ann. Soc. Ent. France, 108: 76-78) has described the larva of this European species. The body is 4.6 mm. long and closely resembles that of *inordinatus*. The head is broader than high, the antennal orbits circular and with the three sensilla on a slight elevation. The labrum is broad, bilobed, and has a few setae and sensory cones near the anterior margin; the margin is not pigmented but there is a weak median band. The mandibles are exactly as in *inordinatus* and the maxillae similar but with the lacinial area acutely produced. The labial palpi are short, the spinnerets acutely pointed and about twice as long as the palpi.

**Ammoplanus perrisi** Giraud

Maneval (1939, ibid., pp. 80-81) has also described the diapausing larva of this species. The body is only 2.25 mm. long, with prominent pleural lobes and dorsal convexities, and is entirely clothed with small, pale setae. The head is subcircular in anterior view and more or less evenly clothed with short setae; antennal papillae are present and moderately long; parietal bands are absent. The labrum is not emarginate apically and is without setae or spines. The mandibles have three strong teeth and a weak fourth tooth basad of these. The maxillae have numerous short setae apically; the palpi are prominent, cylindrical; the lacinial area is reduced and without spinules. The labial palpi are unusually long and slender; the spinnerets are prominent, conical, and laterad of each spinneret is a long, sharply pointed process.

Michener (1953, Kansas Univ. Sci. Bull., 35: 990) remarks that the maxillary galeae are absent in *Ammoplanus*. It is true that Maneval omits them entirely from his sketch and description, but it should be remembered that the larva of *Ammoplanus* is very small, and Maneval may merely have been unable to see the galeae clearly in his preparation. It seems to me probable that, had Maneval been certain that the galeae were absent, he would have remarked on this fact. Galeae are present in all other known sphecid larvae.

## Explanation of Figures

In drawings of the head, the anterior aspect is shown on the left side, the posterior aspect on the right side. In drawings of the labrum, the upper or anterior surface is shown on the left side, the under or posterior surface (epipharynx) on the right side.

PLATE II

Fig. 1.—*Astata unicolor* Say, body of non-diapausing individual.
Fig. 2.—Same, body of diapausing individual, from cocoon.
Fig. 3.—Same, antenna.
Fig. 4.—Same, portion of integument of prothorax under high magnification.
Fig. 5.—Same, head.
Fig. 6.—Same, labrum and epipharynx.
Fig. 7.—Same, spiracle.
Fig. 8.—Same, right maxilla and right half of labium.

PLATE III

Fig. 9.—*Tachytes elongatus* Cresson, body of diapausing larva.
Fig. 10.—Same, anterior part of body, ventral aspect.
Fig. 11.—Same, antenna.
Fig. 12.—Same, apex of maxilla.
Fig. 13.—Same, head.
Fig. 14.—Same, portion of integument of prothorax under high magnification.
Fig. 15.—Same, labrum and epipharynx.
Fig. 16.—Same, apex of labium, oral surface.
Fig. 17.—Same, spiracle.

PLATE IV

Fig. 18.—*Tachytes mandibularis* Patton, labrum and epipharynx.
Fig. 19.—Same, apex of maxilla.
Fig. 20.—Same, apex of labium, oral aspect.
Fig. 21.—*Tachysphex terminatus* (Smith), head.
Fig. 22.—Same, anterior portion of body.
Fig. 23.—Same, labrum and epipharynx.
Fig. 24.—Same, apex of maxilla.
Fig. 25.—Same, apex of labium, oral aspect.
Fig. 26.—Same, mandible, ventral (posterior) view.
Fig. 27.—Same, spiracle.
Fig. 28.—Same, portion of integument of dorsum of prothorax.

PLATE V

Fig. 29.—*Larropsis distincta* (Smith), body.
Fig. 30.—Same, anterior portion of body.
Fig. 31.—Same, portion of integument of prothorax under high magnification.
Fig. 32.—Same, mandible, dorsal (anterior) view.
Fig. 33.—Same, head.
Fig. 34.—Same, spiracle.
Fig. 35.—Same, antenna.
Fig. 36.—Same, apex of labium, oral surface.
Fig. 37.—Same, labrum and epipharynx.
Fig. 38.—Same, apex of maxilla.

PLATE VI

Fig. 39.—*Liris haemorrhoidalis magnifica* (Kohl), head.
Fig. 40.—Same, mandible, ventral (posterior) aspect.
Fig. 41.—Same, labrum and epipharynx.
Fig. 42.—*Solierella blaisdelli* (Bridwell), body.
Fig. 43.—*Solierella* sp., head.
Fig. 44.—Same, labrum and epipharynx.
Fig. 45.—Same, apex of maxilla.
Fig. 46.—*Astata occidentalis* Cresson, mandible.
Fig. 47.—Same, apex of labium, oral surface.
Fig. 48.—Same, labrum and epipharynx.

PLATE VII

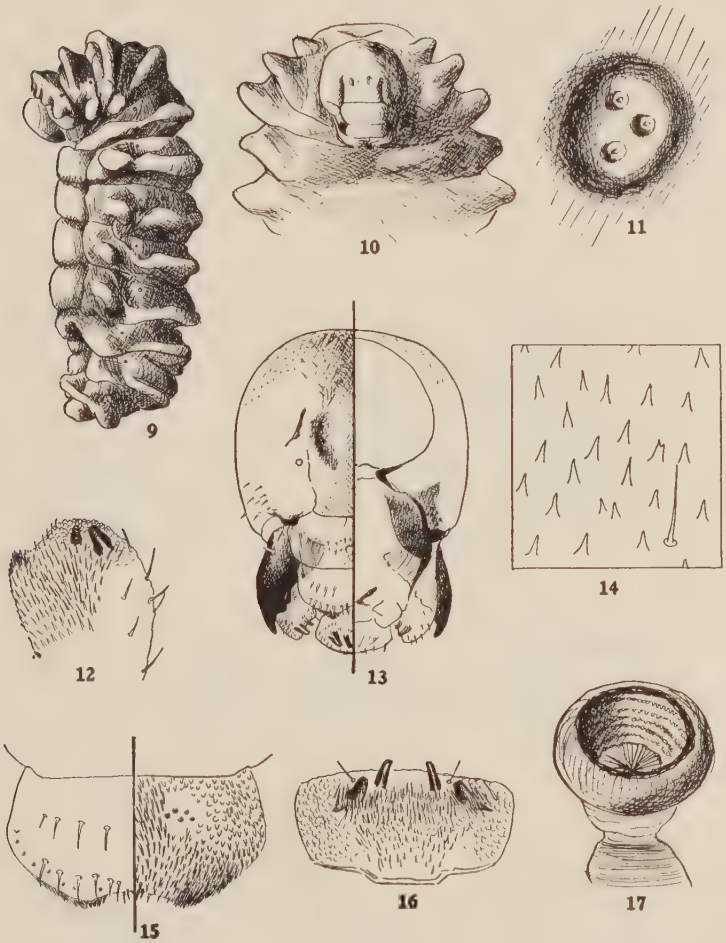
Fig. 49.—*Pemphredon tenax* Fox, body.
Fig. 50.—Same, head.
Fig. 51.—Same, portion of integument of venter of thorax under high magnification.
Fig. 52.—Same, spiracle.
Fig. 53.—Same, labrum and epipharynx.
Fig. 54.—Same, mandible, ventral (posterior) aspect.
Fig. 55.—Same, apex of maxilla and labium.
Fig. 56.—*Pemphredon concolor* Say, anterior half of head.
Fig. 57.—*Pemphredon giffardi* (Rohwer), labrum.
Fig. 58.—*Larra analis* Fabricius, mandible, dorsal (anterior) aspect.
Fig. 59.—Same, mandible, mesal aspect.

PLATE VIII

Fig. 60.—*Passaloecus mandibularis* (Cresson), body.
Fig. 61.—Same, head.
Fig. 62.—Same, portion of integument of dorsum of thorax under high magnification.
Fig. 63.—Same, apex of maxilla and labium.
Fig. 64.—Same, labrum and epipharynx.
Fig. 65.—*Xylocelia franclemonti* Krombein, spiracle.
Fig. 66.—Same, labrum and epipharynx.
Fig. 67.—*Xylocelia virginiana* Rohwer, right maxilla and right half of labium.
Fig. 68.—*Stigmus inordinatus* Fox, labrum and epipharynx.
Fig. 69.—Same, apex of maxilla and labium.

Astata unicolor Say

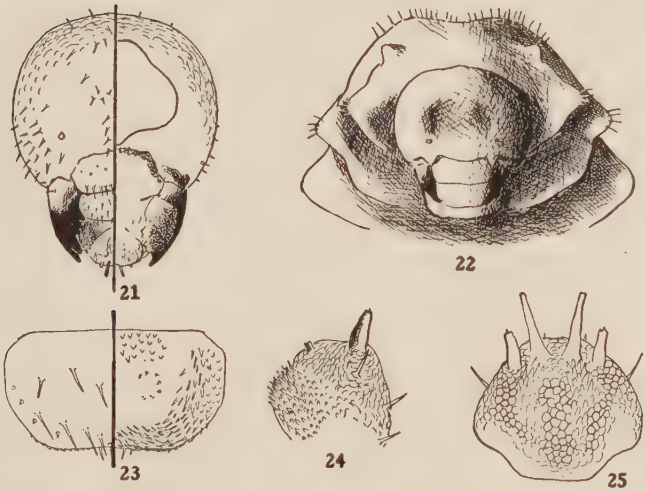
EVANS: LARVAE OF DIGGER WASPS



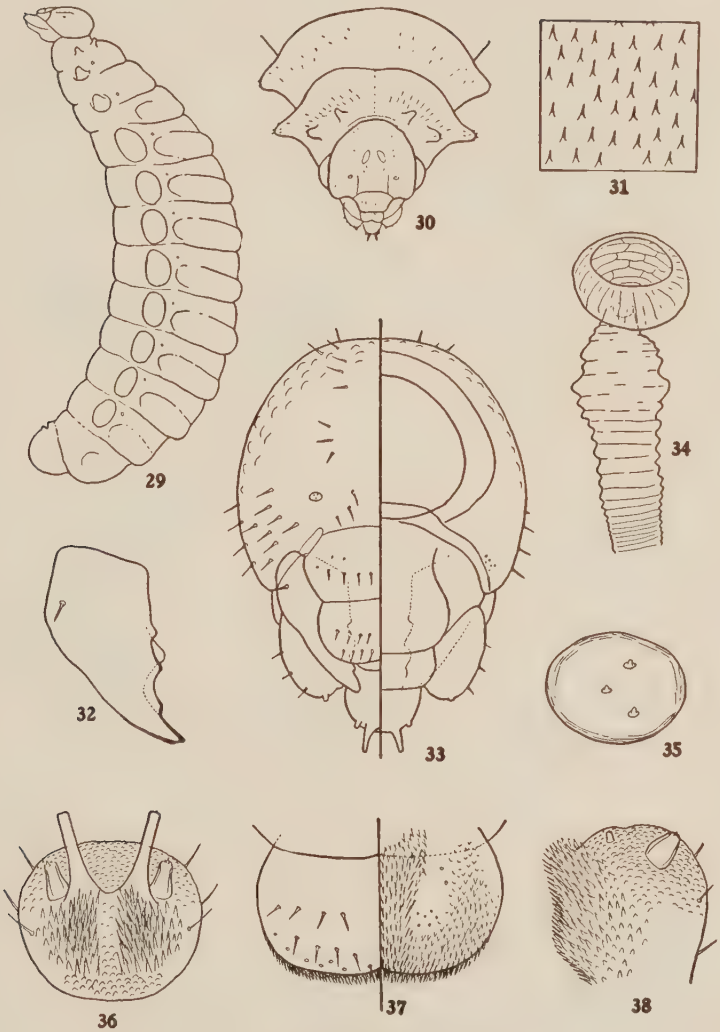

Tachytes elongatus Cresson

EVANS: LARVAE OF DIGGER WASPS

Tachytes mandibularis Patton

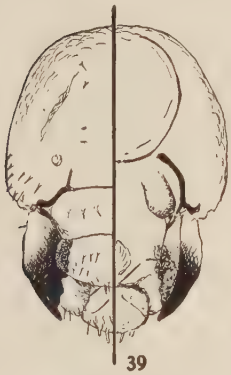



Tachysphex terminatus (Smith)




Larropsis distincta (Smith)

EVANS: LARVAE OF DIGGER WASPS



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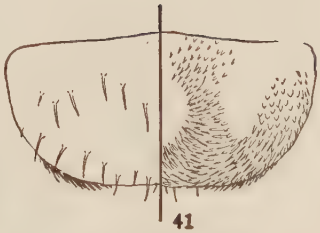

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Liris haemorrhoidalis magnifica (Kohl)

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Solierella blaisdelli (Bridwell)

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Solierella sp.

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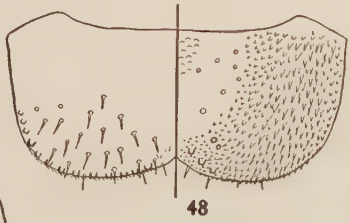
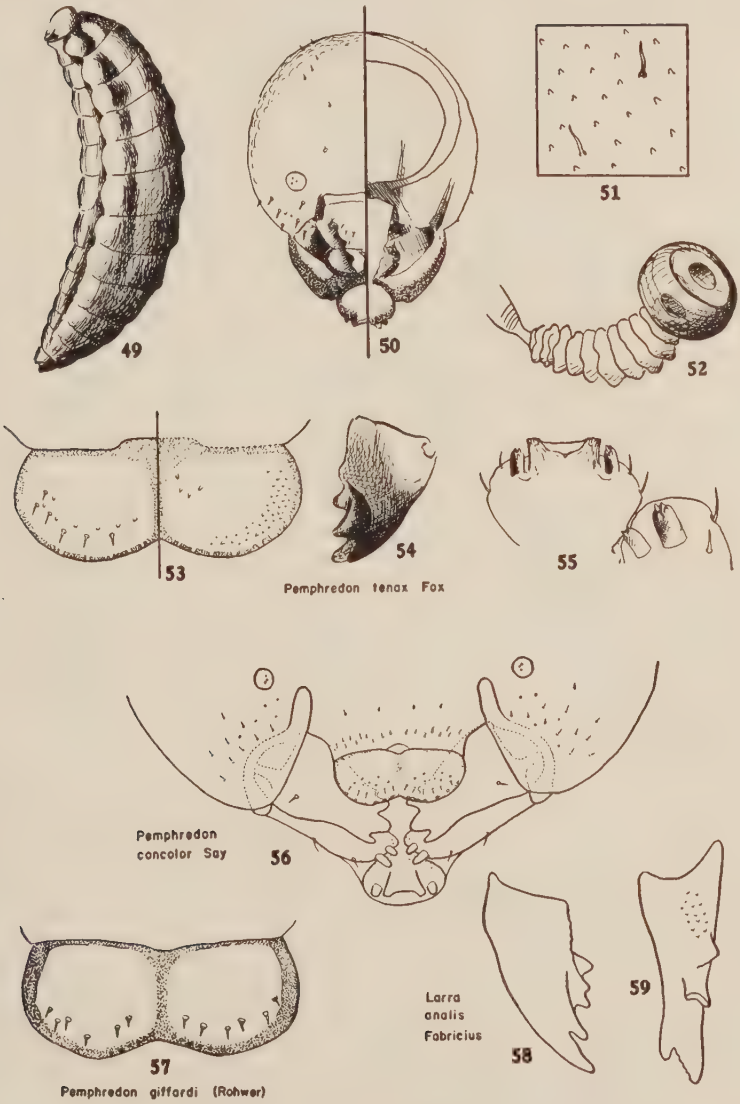


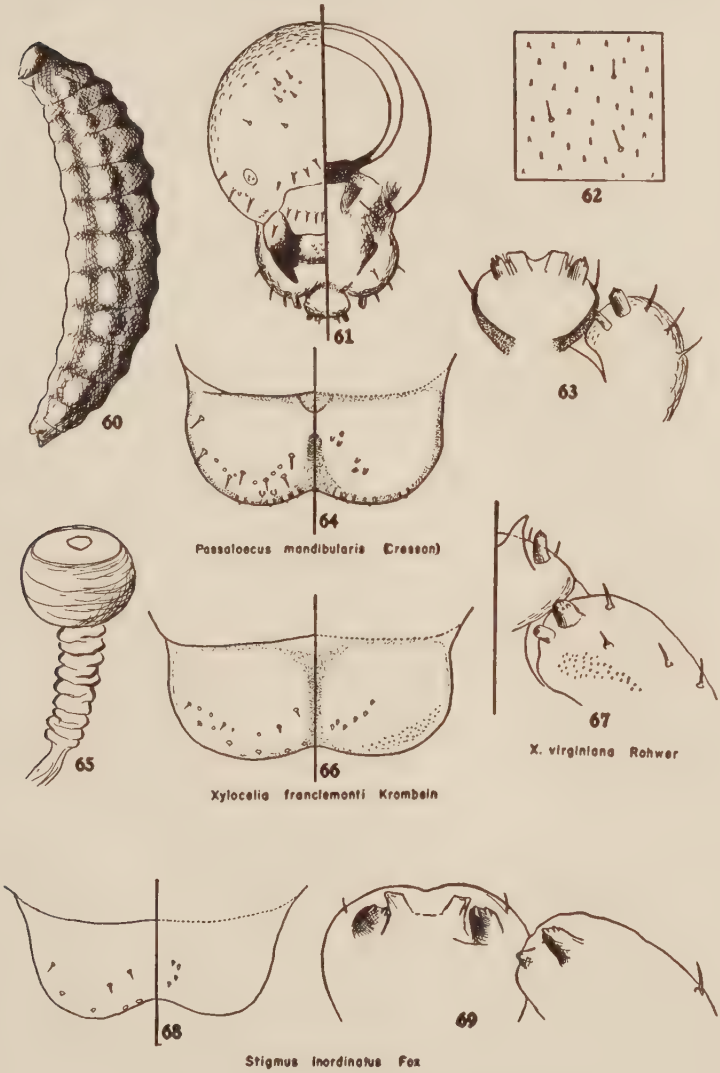
48

Astata occidentalis Cresson

EVANS: LARVAE OF DIGGER WASPS




EVANS: LARVAE OF DIGGER WASPS




EVANS: LARVAE OF DIGGER WASPS

# BIOLOGY AND TAXONOMY OF THE CUCKOO-WASPS OF COASTAL NORTH CAROLINA (HYMENOPTERA, CHRYSIDIDAE)

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The observations reported here are based primarily on material collected or reared by the author at Kill Devil Hills on the Outer Banks of North Carolina from 1948 through 1956.[1] Collateral biological and taxonomic investigations of the other families of wasps except Bethylidae occurring in this coastal area have been reported elsewhere (Krombein, 1950, 1951, 1953a, b, 1955, 1956, 1958a).

Thus far ten species of Chrysididae have been collected in the field or reared from wooden trap nests. Collection dates, flower or foliage visiting records, and habitat preferences are cited below for the eight species collected in the field, *Hedychrum violaceum* Brullé, *Chrysis* (*C.*) *equidens* Viereck, *C.* (*C.*) *conica* Brullé, *C.* (*C.*) *stenodyneri*, n. sp., *C.* (*C.*) *derivata* Buysson, *C.* (*Pyria*) *fabricii* Mocsáry, *C.* (*P.*) *smaragdula* Fabricius, and *Parnopes westcottii atlanticus*, n. subsp. Host preferences, life-history data, and descriptions of the cocoons are also presented for six species of Chrysididae reared from wooden trap nests provisioned by various species of solitary Vespidae and Sphecidae, as follows: *Chrysis* (*Trichrysis*) *parvula* Fabricius reared from the sphecid, *Trypoxylon* (*Trypargilum*) sp., probably either *clavatum* Say or *rubro-cinctum* Packard; *C.* (*C.*) *alabamensis*

[1] The field collecting in 1950 and the trap-nest investigations in 1955 were supported by grants-in-aid from the American Philosophical Society, which are herewith gratefully acknowledged. I am indebted to the following specialists for assistance: G. W. Byers, University of Kansas, for the loan of the type of *Chrysis equidens* Vier.; H. W. Capps and A. B. Gurney, Entomology Research Division, for identification of lepidopterous larvae and cockroaches; H. J. Grant, Jr., Academy of Natural Sciences of Philadelphia, for the loan of paratypes of *Parnopes diadema* Vier.; and I. H. H. Yarrow, British Museum (Natural History), for notes on several types of *Parnopes* in that collection.

Mocsáry reared from the sphecid, *Podium carolina* Rohwer; *C.* (*C.*) *stenodyneri,* n. sp., reared from the vespids, *Stenodynerus* (*S.*) *ammonia histrionalis* (Robertson), *S.* (*S.*) *krombeini* Bohart, *S.* (*S.*) *lineatifrons* Bohart, and a species of *Stenodynerus* (*Parancistrocerus*), probably *f. fulvipes* (Saussure); *C.* (*C.*) *derivata* Buysson (?) from an unknown vespid; *C.* (*Pyria*) *fabricii* Mocsáry from the vespid, *Rygchium megaera* (Lepeletier); and *C.* (*P.*) *smaragdula* Fabricius from the vespid, *Monobia quadridens* (Linnaeus).

The field work was done in two habitats. The first, referred to hereafter as the barrens, a relatively flat area not over 50 feet above sea level, lying between the ocean and dunes, is characterized by sandy soil and sparse vegetation consisting principally of scrubby *Quercus virginiana* Miller (live oak), *Q. falcata* Michaux (Spanish oak), *Myrica carolinensis* Miller (bayberry), scattered grasses, several extensive stands of *Pinus serotina* Michaux (pond pine), and two small stands of *Cephalanthus occidentalis* Linnaeus (button bush). The other habitat, consisting of dense to open woods, lying west of the dunes and adjacent to Albemarle Sound, is characterized by a sandy loam soil supporting a more diverse and abundant flora with much larger trees.

The traps used for nesting studies were made from pieces of straight-grained pine 165 mm. long and 20 mm. on a side. Each contained a drilled boring 150 mm. long, and 4.8, 6.4, or 12.7 mm. in diameter. Almost all the traps had 4.8 or 6.4 mm. borings. They were made up into sets of four, two of each size boring, and placed more or less horizontally at stations on the barrens or in the woods where solitary wasps might search for a suitable nesting site. The traps were usually placed at heights varying from 30 to 180 cm. above the ground. Many of those on the barrens were exposed to the full sun, but the boring entrances were always shaded during part of the day. In wooded areas the traps were in partial or complete shade. The stations selected most frequently were on or beneath dead limbs of oaks and pines where wasps might search for abandoned beetle borings, but some traps were attached to live branches.

Traps C 1-345 were placed at 88 stations on June 21-22, 1955, and were checked for the first time on July 21-22. Traps C 346-

398 were set out July 21-22 to replace the provisioned traps which were picked up on those dates; in addition, traps C 399-513 were set out at 29 new stations on July 22-23. All traps were examined again September 15-18, and the completed or partially stored traps were removed from the stations. The rest of the traps were left at the stations during the winter, and were next examined July 29-30 and again on August 10, 1956. Traps C 601-629 were set out as replacements for the stored ones collected on July 29-30; in addition, traps C 630-727 were placed at 25 new stations on July 31. The final check was made on September 8-9, 1956, at which time all traps were picked up. Both in 1955 and 1956 the overwintering nests were kept outside at Arlington, Virginia from October to mid-April; possibly the occupants would have emerged a week or two earlier had the nests been kept at Kill Devil Hills during the winter, but since these traps were against a masonry surface with a southern exposure the development may have been accelerated.

It was not possible to obtain any information on the manner of parasitism because, due to the travel involved, the traps were examined at such infrequent intervals. However, it is certain that none of the six species of cuckoo-wasps reared at Kill Devil Hills are prepupal (or pupal) parasites, since none were found inside the cocoon of the host wasp. The presence of some undevoured specimens of prey in most cells parasitized by these chrysidids also indicates that the host larva did not reach maturity. I expect that the pattern when eventually discovered will be something like this: [2] The chrysidid egg is deposited in the cell while the host wasp is provisioning it; the chrysidid larva, a highly modified form with strongly chitinized head and heavy mandibles, usually hatches earlier than the host larva, and immediately seeks out the host egg or newly hatched larva and devours it; then it molts to the normal form of wasp larva and begins to feed on the prey stored for the host; it reaches maturity before using all the prey unless the host wasp has stored less than the normal amount.

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[2] Based on unpublished data on an apparently new species of *Chrysis* (*Trichrysis*) parasitic on species of *Trypoxylon* at Plummers Island, Maryland.

**Hedychrum violaceum** Brullé

This species occurs both on the barrens and in the woods, and I have taken males visiting honeydew on foliage of *Quercus falcata*. Dates of capture are as follows: 3 ♀♀, June 27-July 5, 1950; 5 ♂♂, May 24-26, 1952; 7 ♀♀, 6 ♂♂, June 21-July 3, 1954.

A female, now in the U. S. National Museum, was dug out of a nest of *Cerceris architis* Mickel in the ground by J. C. Bridwell at Clifton, Fairfax Co., Virginia, July 1-9, 1933.

**Chrysis (Trichrysis) parvula** Fabricius

I have never seen this species in the field at Kill Devil Hills, but I reared a male from a wooden trap nest (C 380). This trap had a boring of 6.4 mm. diameter, and was set out in the woods in a horizontal position on a fallen dead pine limb 2 meters above the ground, July 22, 1955. It had been stored by a species of *Trypoxylon* (*Trypargilum*), probably *clavatum* Say or *rubro-cinctum* Packard,[3] by September 15, when I collected it. When I opened the trap on September 26 it contained two cells, the first with desiccated spiders and the second with a chrysidid cocoon. There were several narrow sand and mud annuli 25, 42, and 57 mm. above the partition closing cell 2, and then a final mud and sand partition 3 mm. thick and 63 mm. above cell 2. The chrysidid emerged from cell 2, May 21, 1956.

The cocoon is 8 mm. long, cylindrical with rounded ends, and a diameter of 4.5 mm. It is constructed of dark brown, opaque, brittle varnished silk, and has a small patch of dense, opaque silk near the anterior end.

Published host records for this species are *Trypoxylon clavatum* Say and *T. rubro-cinctum* Packard (Krombein, 1958b), *Sceliphron caementarium* (Drury) (Harrington, 1896), and *Hylaeus varifrons* (Cresson) (Davidson, 1895). Almost certainly the last one is an erroneous record based on a misidentified chrysidid. *C. parvula* is not known from California, where Davidson did his work. Ashmead determined the chrysidid, but there is no material from California under *parvula* in the U. S. National Museum.

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[3] These are the only species of *Trypoxylon* that I have reared from other trap nests set out in the woods at Kill Devil Hills.

**Chrysis (Chrysis) equidens** Viereck Fig. 6.

I have taken *equidens* almost entirely on the barrens where it is one of the most abundant species of cuckoo-wasps. Dates of capture are as follows: 3 ♀♀, 3 ♂♂, May 23-27, 1948; 11 ♀♀, 4 ♂♂, June 27-July 16, 1950; 1 ♀, 1 ♂, May 24, and 1 ♀, July 31, 1952; 6 ♀♀, 1 ♂, June 21-July 3, 1954; 1 ♀, August 4, 1956. Five females and one male were taken on foliage of *Quercus falcata,* two females on *Q. virginiana,* and one female on *Liquidambar styraciflua.* The species apparently does not visit flowers for nectar.

There are no host records for *equidens.* I suspect that it is parasitic on ground-nesting wasps or bees, for almost all of the specimens, except those taken on foliage, were caught while they were on or flying low over the surface of the sand. However, I never saw them investigating burrows in the ground as was the case with *Parnopes westcottii atlanticus,* new subspecies.

*Chrysis equidens* is similar in appearance to *C. montana* Aaron and *C. dorsalis* Aaron, and runs to that section of Aaron's key (p. 233). The species belonging to this group are rather small forms with long, erect hair on the sides of first two abdominal terga, lateral margins of third tergum bisinuate, transverse facial carina evanescent or absent, and fore tibial spur very long and slender.

Both sexes of *equidens* have the second and third abdominal sterna rather dull and mostly black except for a small, short, blue stripe or spot along the midline on basal half, the emargination between median teeth of third tergum very shallow, the depth of the emargination no more than half the width between apices of teeth, and disk of third tergum with close but separated punctures.

*C. montana* was based on two conspecific females from Montana. It differs from females of *equidens* in having the second and third sterna shining and blue, except narrowly on sides and at apices, and deeper emargination between median teeth of third tergum, the depth equal to the distance between apices of teeth.

The type and seven paratypes of the original series of ten specimens of *dorsalis* are in the Philadelphia collection. The

type is a male from Colorado and it is conspecific with the six male paratypes from Montana and Washington. The female paratype from Vancouver may not be correctly associated. Males of *dorsalis* differ from those of *equidens* in having the second and third sterna shining and blue, except narrowly on sides and at apices, and the disk of third tergum mostly contiguously punctate. The male genitalia are also distinct: In *dorsalis* the paramere dorsally is broad, tapers slightly toward the apex, and is abruptly narrowed near the apex with a very short, stubby posterolateral projection, while in *equidens* the paramere narrows more rapidly and has a relatively long, slender digitate process; the cuspis in *dorsalis* narrows very slightly toward the rounded apex, while in *equidens* the inner edge converges toward the outer on the apical fourth so that the apex is more pointed; the digitus in *dorsalis* is shorter, stouter, and reaches about two-thirds of distance to tip of cuspis, while in *equidens* it is longer, more slender, and extends about three-fourths of distance to apex of cuspis; and the aedeagus of *dorsalis* extends to apex of paramere, but is not quite so long in *equidens* (compare figs. 5 and 6).

Other species belonging to this complex are *aaroni* Mocsáry (= *hirsuta* Aaron, preocc.), described from Montana and Utah, and an undescribed species, usually misidentified as *aaroni* or *montana,* that I have seen from New Jersey, Virginia, Florida, Texas, Missouri, Kansas, Iowa, Illinois, and Michigan. Male genitalia in this group offer excellent characters and on this basis the rather small number of available males belong to only three species, one species occurring west of the 100th Meridian and two east of it. If this reflects the actual situation in the field, then the names *aaroni, montana,* and *dorsalis* all apply to the same species. The rather dull second and third abdominal sterna with very restricted blue markings will separate both sexes of *equidens* at once from the other species. I have seen specimens of *equidens* from North Carolina, Texas, Kansas, and Nebraska.

**Chrysis (Chrysis) conica** Brullé

I collected a male of this species August 3, 1956, on foliage of a scrubby *Quercus virginiana* on the barrens.

It has been reared from a clay cell of a species of *Eumenes* (Krombein, 1958b).

**Chrysis (Chrysis) alabamensis** Mocsáry Fig. 4.

I have never collected this species in the field at Kill Devil Hills, but I have reared it several times from wooden trap nests stored with cockroaches by the sphecid wasp, *Podium carolina* Rohwer. Rearing data indicate that there are two or more generations a season of both the chrysidid and the host wasp. Trap nest rearings from both Florida and North Carolina suggest that *Podium carolina* may be its chief host. The chrysidid is not known to occur outside the range of this host.

*Podium carolina* is found in open wooded areas and probably usually nests in abandoned beetle borings or other cavities in dead wood. Rau (1937) records it as nesting in abandoned clay cells of *Sceliphron caementarium* (Drury). At Kill Devil Hills, *carolina* accepts both 4.8 and 6.4 mm. diameter borings in the trap nests, although the larger diameter is utilized somewhat more frequently when both sizes are available. The female *carolina* provisions her single-celled nest with four to six cockroach nymphs or adults which are placed on their backs, heads inward, near the inner end of the boring. The wasp egg is deposited on the sternum of the innermost cockroach. *Chorisoneura texensis* S. and Z. is the cockroach stored most commonly at Kill Devil Hills, but occasionally specimens of *Parcoblatta* sp., *Ischnoptera* sp., or *Cariblatta lutea* (S. and Z.) may be used. Ordinarily each nest is stored with only one species of cockroach.

The closing plug is constructed at the boring entrance or as much as 40 mm. inside the entrance, leaving a brood cell 100-140 mm. in length; the plug averages 6.5 mm. in thickness (range 3-20 mm. in 10 nests) and is composed of varied materials pressed tightly together and coated on the outside with a layer of resin 1-3 mm. thick. In several nests the wasp rasped wood fibers from inside the boring to construct the main part of the plug, but usually the plug was made from small fragments of dead wood, presumably obtained from the dead limb on which the trap was tied, frequently with some interwoven silk strands or webbing.

Five of the nests (C 136, 248, 387, 627, 629) parasitized by *alabamensis* had borings 6.4 mm. in diameter, and two (C 381, 385) 4.8 mm. Four of the nests (248, 385, 387, 627) were from

the same station, a dead stub of a limb of *Quercus falcata,* shaded during most of the day, and about 1.5 meters above the ground. The other three parasitized nests (136, 381, 629) were at different stations—the first on a dead pine limb 2 meters above the ground in partial shade, the second on a dead pecan limb 1.4 meters above the ground and shaded most of the day, and the third on a dead pine limb 1.5 meters above the ground in partial shade. Three specimens of *Podium* (C 135, 246, 386) developed concurrently with, and at the same stations as, three of the chrysidids (136, 248, 387); presumably each pair of nests was provisioned about the same time and perhaps by the same *Podium* female.

One nest (C 248) was stored between June 21 and July 22, 1955, and the chrysidid prepupa died in the cocoon. Three nests (C 136, 381, 385) were provisioned between July 22 and September 15, 1955, and contained chrysidid cocoons when they were examined September 23-26; these nests yielded, respectively, a male on May 22, and females on May 23 and 31, 1956. Another nest (C 387) was stored by July 30, 1956, and contained a chrysidid cocoon on that date; a female emerged on August 12. The other two nests (C 627, 629) were stored between August 10 and September 9, 1956, and contained chrysidid cocoons when I examined them on September 10; a female emerged from C 627 on May 14, 1957, and the prepupa in C 629 died.

The chrysidid larva does not require all the cockroaches stored by the host, nor does it devour the more strongly chitinized parts such as the sclerites and wings. When the larva begins to spin it usually compacts the cockroach remains at one end of the cell and spins its cocoon adjacent to this mass. It first spins a transparent outer sheath of silk 10-25 mm. long, loosely attached to the boring walls, and occasionally incorporates some of the wings or sclerites of the cockroaches. Then it constructs the cocoon proper which is about 11 mm. long (range 7-15 mm.), 4-5 mm. in diameter at the middle, and tapers slightly toward the rounded ends. It is composed of rather brittle silk impregnated with dark-brown varnish and has a small cap at the anterior end of dense, brown, unvarnished silk. It is suspended from the outer sheath by a network of silk threads.

The cocoon wall is usually so nearly opaque that it is difficult to observe the pupal development. In one case (C 381) there was an entirely pale pupa in the cocoon on May 7. The eyes were light tan on the 9th and 2 days later were black. Between May 15 and 18 the body darkened gradually except for the appendages and venter of abdomen. The pupa was entirely dark by the 21st. The adult female eclosed on May 25 and remained in the cocoon until the 28th.

There is no requirement for *alabamensis* to emerge before its host, inasmuch as *Podium* does not construct a multiple-celled nest. Rearing data are too meager to permit generalization on relative emergence dates at this time. In 1956 emergence dates for one male and one female *Podium* were May 17 and 19 and for one male and two females of *alabamensis* May 22, 28, and 31; but in 1957 a female *alabamensis* emerged May 14, five days before a female *Podium*.

Reared females agree in all important details of sculpture and color with the original description of *alabamensis* Mocsáry. The closest known relative is *laminifera* Bischoff. These two species belong to a small complex in which both sexes have the lateral margin of the third abdominal tergum bowed outward in the middle so that the distance across the lateral margins at base is noticeably less than at middle of segment. The following key will separate these two species:

Transverse facial carina evanescent but anterior ocellus enclosed by a horseshoe-shaped carina which is open below; neck without a pair of very deep pits in middle; postscutellum unarmed; propodeal enclosure with a short, median compressed tooth near base; first and second abdominal terga posterolaterally right-angled, not dentate; third sternum dull, with dense minute punctures separated from each other by no more than the width of a puncture; trochanters, femora and tibiae of male clothed beneath with very dense, long, soft, erect hair. Fig. 4. *alabamensis* Mocsáry

Transverse facial carina well developed, bisinuate, the central section curved upward in middle and the lateral arms curved upward toward upper inner eye margin, anterior ocellus not surrounded by a carina; neck with a pair of very deep pits in middle; postscutellum with a short, suberect, median lamella at apical margin; propodeal margin unarmed; first and second abdominal terga with a small acute tooth at posterolateral angles; third sternum shining, the minute punctures sparser and separated by several times the diameter of a puncture, vestiture of legs of male normal, sparse, unmodified. Fig. 3. ..... *laminifera* Bischoff

**Chrysis (Chrysis) stenodyneri,** new species Figs. 1, 2, 8.

*C. stenodyneri* appears to be closest to *venusta* Cresson of the described species. Both sexes agree in the shape of the lateral margin of third abdominal tergum, thickened and sulcate edges of apical emarginations of third tergum, and slightly raised lateral margins of facial concavity; the females of both species have the head strongly rounded above the eyes; and the males of both have the two basal flagellar segments each slightly shorter than the pedicel. Females may be distinguished as follows: head subcircular in frontal view in *stenodyneri,* the width 1.1 times the height from apex of clypeus, while in *venusta* the head width is 1.2 times the height; malar space one-third the eye height in *stenodyneri* and about one-eighth the eye height in *venusta;* and facial concavity in *stenodyneri* more coarsely punctate laterally and with a narrower strip of transverse, arcuate coarser carinulae along midline, while in *venusta* these punctures are finer and there is a broader median strip of finer carinulae. The males may be separated as follow: head width 1.3 times the height in *stenodyneri,* 1.2 times in *venusta;* malar space 0.25 times the eye height in *stenodyneri,* and 0.15 in *venusta;* and facial concavity more coarsely sculptured in *stenodyneri* and lacking the dense, silvery appressed hair on the sides which is present in *venusta.*

There is some variation in *stenodyneri* in the size and shape of pits on the third tergum and in wing color. The variation in size and shape of pits seems to be a sex-limited feature, appearing only in the males: The females have eight to ten moderately small pits across the apex, but only one of the males has similar pits, the others having only four very large pits across the apex. The variation in wing color probably is correlated with age of the specimen. Most specimens collected in the field have the forewings moderately infumated from the basal vein almost to the apex, but several old (judging from the tattered condition of the wings) males have the entire forewing more strongly infumated than normal. Conversely, all of the reared specimens, which were killed shortly after they left the cocoons, have almost entirely pale forewings.

Sexual dimorphism is quite marked in *stenodyneri.* The especially noteworthy differences are in the shape of the head in

frontal view, proportions and coloration of basal flagellar segments, and shape of the lateral margin of third tergum. Males and females run to two different sections of Aaron's key using the latter character.

*Type.*—♀ ; Kill Devil Hills, Dare Co., North Carolina; May 19, 1956 (K. V. Krombein; reared from wooden trap nest C 30, cell 6, of *Stenodynerus* (*S.*) *krombeini* Bohart) [U. S. National Museum, Type No. 64202].

Length 8.3 mm. Forewing including tegula 5.6 mm. Dark metallic blue, the abdominal dorsum with a slight purplish cast, the following black—mandible except base, flagellum except first segment entirely and second segment above, normally retracted basal areas of second and third terga, an elongate spot on each side of midline of second sternum at base, basal half of third sternum and tarsi except basitarsus. Wings pale hyaline, the marginal cell slightly clouded; veins dark brown. Pubescence pale, generally short, erect and inconspicuous.

Head subcircular in frontal aspect, the width 1.1 times the height from apex of clypeus, the interocular distance at transverse facial carina 0.56 times the width; sides of face below eyes parallel, the width at mandibular condyles 0.8 times the greatest head width; head strongly arched above eyes; in dorsal view the length from transverse facial carina to occiput, half the head width and 0.8 times the interocular distance at level of posterior ocelli; mandible slender at tip, with an inner blunt tooth a fourth of the distance toward base; clypeus with median length about equal to the diameter of an antennal fossa, tumid in middle, the apical margin very slightly incurved for a distance equal to half the clypeal width, with moderately close, rather small punctures except narrow apical rim; facial concavity trapezoidal in outline, the width at base of clypeus 1.35 times the height and 1.8 times the width at transverse facial carina, the sides strongly raised above level of eyes, the basin moderately concave with larger punctures above and laterally, becoming progressively smaller toward midline, a narrow central strip with fine arched carinae and a few small punctures; transverse facial carina moderately strong, the sides curved downward to meet the lateral ridges of facial concavity; dorsum of head and temples with rather coarse, confluent punctures; ocelli arranged in a low triangle, situated a little closer to facial carina than to occiput, the posterior pair not in pits but so placed as to look outward and backward; postocellar line a bit longer than ocellocular line; malar space with length equal to width at mandible and one-third the eye height; temporal carina strong, extending upward from mandible to a point opposite facial carina; relative lengths of scape, pedicel and first three flagellar segments as 15:7:8:5:5.

Pronotum at humeri 0.8 times the head width, the median length of disk 0.4 times the humeral width and two-thirds the head length from facial

carina to occiput; viewed from above the humeri slightly projecting, the sides of pronotal disk slightly bisinuate; prehumeral slope almost perpendicular, with close, moderately small punctures except for a smooth rounded area in middle; dorsum of thorax sculptured similarly to dorsum of head except scutellum with the pits somewhat shallower and a little separated; scutum moderately convex, the length 0.6 times the width; notaulices well developed, parallel except anteriorly where they are divergent; parapsidal furrows straight, weak, present only on median third; scutellum half as long as scutum and more strongly convex; postscutellum moderately convex, two-thirds as long as scutellum; mesopleuron with moderately large, confluent pits above the oblique foveate groove, vertical carina on lower half without projections; metapleural spine short and stout; propodeum abruptly and almost perpendicularly declivous posteriorly, viewed from above the posterolateral projection is short and acutely angulate (about 45°); U-shaped propodeal groove very broad, crossed by a few weak carinae, the enclosed area sculptured like postscutellum.

Relative median lengths of abdominal terga as about 2:3:2; declivous part of first tergum with a relatively broad, shallow depression and a narrow deeper median groove which extends back onto dorsal surface two-thirds of distance to apex; disk of first tergum with moderately small, somewhat separated punctures which become a little larger and confluent anterolaterally, interspersed minute punctures absent; second tergum with punctures of similar size and spacing, becoming denser laterally and with a few interspersed minute punctures along side, apical margin sulcate, half as thick as transverse diameter of anterior ocellus, the posterolateral corner extending farther downward than base of third tergum; third tergum with lateral margins slightly bisinuate, disk with contiguous, somewhat larger punctures than on second tergum; submarginal foveate groove deeply impressed, along sides extending two-thirds of distance to base, the section across apex of tergum with about eight large pits; apical teeth relatively short, the outer pair with apex rounded, the inner pair acute and closer to each other than either is to the adjacent outer tooth; emarginations between teeth thickened and with a crescentic sulcus which in middle is 0.8 times as thick as transverse diameter of anterior ocellus; median emargination deeper than lateral.

Female paratypes vary in length from 7.0 to 9.2 mm. The coloration is as described for the type except that several specimens have a few metallic greenish reflections on sides of head and thorax, and all field collected specimens have the forewing moderately infumated from basal vein nearly to apex. The body proportions and sculpture also are as in the type except that some specimens have the apical margin of third tergum thinner but still sulcate.

*Allotype.*—♂; Kill Devil Hills, Dare Co., North Carolina; May 3, 1957 (K. V. Krombein; reared from wooden trap nest C 32, cell 2 of *Stenodynerus* (*S.*) *krombeini* Bohart) [USNM].

Length 7.1 mm. Forewing including tegula 5.1 mm. Color as in type except flagellum entirely black and apex of third sternum pale, membranous and semitransparent.

Head as in female except as follows: in frontal aspect with the width 1.3 times the height from apex of clypeus, the interocular distance at transverse facial carina 0.58 times the width; sides of face below eyes convergent at about 45°, the width at mandibular condyles 0.58 times the greatest head width; head rounded above eyes but not so strongly as in female; in dorsal view the length from transverse facial carina to occiput 0.44 times the head width and two-thirds the interocular distance at level of posterior ocelli; facial concavity subquadrate, the upper width slightly less than lower width, the central strip with close arched carinae and somewhat broader than in female; postocellar and ocellocular distances subequal; malar space one-fourth the eye height; relative lengths of scape, pedicel and first three flagellar segments as 12:5:4:3:6.

Thorax as in female except as follows: median length of pronotal disk one-third the humeral width.

Abdomen as in female except as follows: posterolateral corner of second tergum not extending so far downward as compared to base of third tergum; lateral margin of third tergum strongly arcuate; submarginal foveate groove with four large pits on apical section; teeth and emarginations shaped as in female, but edges of emarginations thicker, that in middle thicker than lateral and 1.2 times as thick as transverse diameter of anterior ocellus.

Male paratypes vary in length from 5.7 to 9.0 mm. The coloration is as described for the allotype except that most specimens have some metallic green reflections on sides of head and thorax, and all field collected specimens have the wings more strongly and widely infumated. The body proportions and sculpture are as in the allotype except that one of the males has eight to ten smaller pits across apical section of foveate groove on third tergum.

*Cocoon.*—A single layer of light tan, transparent, brittle varnished silk, with 1-4 (usually 2-3) short narrow strips of dense, opaque paler silk on sides near head end; anterior end flat, 4.8 mm. in diameter (6.4 in one case); posterior end rounded, usually narrower; cocoon cylindrical in a few cases, but usually immediately narrowed near head end and then tapering very gradually

toward posterior end, 7-9 mm. long. After eclosion the adult escapes from the cocoon by cutting a more or less circular flap out of the anterior end.

*Paratypes.*—7 ♀♀, 9 ♂♂, all topotypical and collected or reared by the author, with the following additional label data: 1 ♂, July 3, 1950; 1 ♂, July 28, 1952 (on foliage of *Quercus falcata*); 1 ♀, 1 ♂, July 30, 1952 (on foliage of *Q. virginiana*); 1 ♂, July 31, 1952 (on foliage of *Q. virginiana*); 1 ♂, August 5, 1952 (on foliage of *Q. virginiana*); 1 ♂, May 14, 1956 (reared from trap nest C 30, cell 7); 2 ♂♂, May 15, 1956 (reared from C 70, cell 1 and from C 348, cell 3); 2 ♀♀, May 16, 1956 (reared from C 474, cells 2 and 3); 1 ♀, May 17, 1956 (reared from C 479, cell 2); 1 ♀, May 22, 1956 (reared from C 447, cell 1); 1 ♀, May 31, 1956 (reared from C 475, cell 1); 1 ♂, May 7, 1957 (reared from C 60, cell 5); 1 ♀, May 13, 1957 (reared from C 700, cell 7). Also 12 ♀♀, 10 ♂♂ as follows: 1 ♂, Long Island, N. Y. (W. H. Ashmead); 1 ♂, Gloucester Co., N. J., July 5, 1891 (W. J. Fox); 1 ♀, Barcroft, Arlington Co., Va., September 3, 1928 (J. C. Bridwell); 1 ♀, East Falls Church, Arlington Co., Va., May 11, 1911 (P. B. Rohwer, on *Ceanothus*); 1 ♂, Falls Church, Fairfax Co., Va., June 12, 1916 (T. A. Keleher, Jr.); 1 ♀, Dunn Loring, Fairfax Co., Va., August 21, 1949 (K. V. Krombein; on foliage of *Liriodendron tulipifera* bearing honeydew secretions of *Toumeyella liriodendri* (Gmel.)); 1 ♂, Washington, D. C., May 28, 1944; 1 ♂, Tifton, Tift Co., Ga., September 11, 1936 (P. A. Glick); 2 ♂♂, Jacksonville, Duval Co., Fla. (W. H. Ashmead); 1 ♂, Gainesville, Alachua Co., Fla., 10-11-1918 (P. W. Fattig); 3 ♀♀, Orlando, Orange Co., Fla., March 15, 1928 (parasite from wasp nest A), March 1944 (R. & G. Bohart), and May 20, 1925 (O. C. McBride); 1 ♀, Orange Co., Fla., June 21, 1929 (C. Nelson); 1 ♂, Borden, Clark Co., Ind., July 16-18, 1913 (H. Morrison); 4 ♀♀, St. Louis, Mo., Pergande No. 667, and Rau Nos. 3014, 3734 (October 15, 1918, det. as *Tetrachrysis venusta* by Rohwer), and 4122; 1 ♂, Baldwin, Douglas Co., Kans., August (J. C. Bridwell); 1 ♀, Onaga, Pottawatomie Co., Kans. Paratypes are in the collections of the U. S. National Museum, Academy of Natural Sciences of Philadelphia, G. E. Bohart, K. W. Cooper, and the author. Additional paratypes in

the collection of The North Carolina State College bear the following data: 1 ♀, Holly Shelter, Pender Co., October 9, 1954; 1 ♀, Wake Co., May 11, 1955 (D. A. Becker); 1 ♂, Raleigh, Wake Co., June 8, 1949 (R. L. Rabb).

Several females and one male from Texas and Mexico are close to *stenodyneri,* differing chiefly in slightly different head proportions. These may be representatives of a discrete race and are not included in the type series of *stenodyneri.*

*Biology.*—At Kill Devil Hills *Chrysis stenodyneri* occurs only on the barrens. Both sexes are attracted to honeydew secretions of *Phylloxera* or other insects on foliage of *Quercus falcata* and *Q. virginiana.* I have never found it visiting flowers for nectar, though there is one old record of its being taken on *Ceanothus.* It is parasitic on solitary vespids nesting in borings or possibly other cavities in the stunted and bushy specimens of *Q. falcata* and *Q. virginiana* on the barrens. Collecting and rearing data indicate that there are two or more generations a year.

I have reared it from wooden trap nests of the following species: *Stenodynerus* (*S.*) *ammonia histrionalis* (Robt.), nest C 348; *S.* (*S.*) *krombeini* Bohart, nests C 30, 32, 479; *S.* (*S.*) *lineatifrons* Bohart, nests C 60, 700; unidentified species of *Stenodynerus* (*Parancistrocerus*), nest C 475 [subgeneric identification here based on presence of ensliniellid mites in nest which are paraphagic on species of *Parancistrocerus*]; unidentified solitary vespids, probably species of *Stenodynerus,* nests C 70, 447, 474.

The traps were tied to live branches of *Q. virginiana* except C 447, 474, and 475, which were attached to dead branches of *Q. virginiana;* C 700, attached to a dead branch of *Q. falcata;* and C 348, attached to a live branch of *Q. falcata.* The traps were set out in a subhorizontal or horizontal position, 30 to 150 cm. above the ground surface. They were in full sunlight all day long but the entrances were shaded during parts of the day.

I have made no studies of marked females nesting in traps. However, I believe it is probable that a female that has completed a nest, or abandoned a boring because of parasitism, may utilize an empty boring at the same station for her next nest. With the thought that this might give a clue to the identity of

the host wasps, I checked my station records for other nests provisioned at the same time as C 70, 447, 474, 475 with the following results: C 71, stationed with C 70, was used by *Stenodynerus* (*S.*) *krombeini;* C 446 and 448, stationed with C 447, were used by solitary vespids but the nests were destroyed by miltogrammine maggots; C 477, stationed with C 474 and 475, was used by *Stenodynerus* (*Parancistrocerus*) *f. fulvipes* (Saussure).

The lengths, in millimeters, of cells of vespid nests parasitized by *Chrysis stenodyneri* and provisioned by the species indicated are given in the following table. Cell 1 was the innermost cell and the empty vestibule, when present, the outermost. All borings were 150 mm. in length and 4.8 mm. in diameter, except C 32 which was 6.4 mm. in diameter. Male and female signs designate the sex of wasps that were reared to maturity or died in the pupal stage, and V and C indicate that the inhabitant was a vespid or chrysidid. Superscript figures denote the following:

[1] Contents destroyed by miltogrammine larvae (Sarcophagidae)

[2] Cell contained only shriveled lepidopterous larvae (vespid prey)

[3] Wasp larva killed when boring was probed with grass stem

[4] Female vespid pupa killed by prior emergence of a vespid from an earlier cell

[5] Prepupa killed by *Pyemotes* mites

[6] Incompletely stored cell containing lepidopterous larvae (vespid prey)

| Nest | Cell 1 | Cell 2 | Cell 3 | Cell 4 | Cell 5 | Cell 6 | Cell 7 | Cell 8 | Vestibule |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *S. (S.) krombeini* | | | | | |
| C 30 | 10[1] | 13[1] | 16, ♂ V | 15[2] | 13, ♂ V | 12, ♀ C | 12, ♂ C | ..... | .. |
| C 32 | 11. ♀ V | 15, ♂ C | 9[3] | ..... | ..... | ..... | ..... | ..... | .. |
| C 479 | 20, ♀ V | 17, ♀ C | ..... | ..... | ..... | ..... | ..... | ..... | 25 |
| | | | | *S. (S.) lineatifrons* | | | | | |
| C 60 | 26, ♀ V | 20, ♀ V | 22, ♀ V | 15, ♀ V | 19, ♂ C | ..... | ..... | ..... | .. |
| C 700 | 16, ♀ V | 15, ♀ V[4] | 13, ♀ V | 13, ♀ V[4] | 15, ♀ V[4] | 13, ♀ V | 13, ♀ C | 14, ♂ V | 38 |
| | | | | *S. (S.) ammonia histrionalis* | | | | | |
| C 348 | 14, ♀ V | 17, ♀ V | 22, ♂ C | ..... | ..... | ..... | ..... | ..... | 87 |
| | | | | *S. (Parancistrocerus)* sp. | | | | | |
| C 475 | 19, ♀ C | 28, C[5] | incompl.[6] | ..... | ..... | ..... | ..... | ..... | .. |
| | | | | Unidentified vespids, probably species of *Stenodynerus* | | | | | |
| C 70 | 13, ♂ C | incompl.[6] | ..... | ..... | ..... | ..... | ..... | ..... | .. |
| C 447 | 34, ♀ C | ..... | ..... | ..... | ..... | ..... | ..... | ..... | .. |
| C 474 | 34[1] | 33, ♀ C | 36, ♀ C | ..... | ..... | ..... | ..... | ..... | 47 |

Seven of the nests (C 30, 70, 348, 447, 474, 475, 479) were stored by the host vespids between July 21-22 and September 16-17, 1955; these nests were examined September 22-28, and both vespid and chrysidid inhabitants were already in the prepupal state in cocoons, except for the chrysidid in C 70, cell 1, which was spinning its cocoon on September 23. The other nests (C 32, 60, 700) were stored by the host vespids between August 11 and September 9, 1956; they were examined September 9 to 11 and all inhabitants were in the prepupal state in cocoons except for the last two cells (2 and 3) of C 32 which contained nearly full grown wasp larvae.

It is customary for these host vespids to utilize the entire boring for nesting purposes, leaving an empty, capped vestibular cell near the entrance. However, in these ten nests, most of the borings were only partially utilized and it is probable that the host vespids abandoned the nests after one or two cells had been parasitized. Seven of the nests contained only one cell (the outermost) parasitized by a chrysidid, two (C 30, 474) contained chrysidids in the two outer cells, and one (C 700) contained only one chrysidid, in the penultimate cell. One nest contained eight stored cells, one had seven, one had five, three had three, two contained two cells, and two had only one cell. All nests had been stored with paralyzed lepidopterous larvae, but only unidentifiable fragments remained in most nests; two nests (C 474, 475) contained larvae of a species of Tortricidae and there was one larva of a species of Gelechiidae in C 70.

The dates of pupation, adult eclosion, and adult emergence from cells for *Chrysis stenodyneri* and vespid hosts are given below.

| | 1955 Nests, Emergence in 1956 | | 1956 Nests, Emergence in 1957 | |
|---|---|---|---|---|
| | Chrysis | Vespidae | Chrysis | Vespidae |
| Pupation ..... | IV/27 to V/14 | IV/30 to V/21 | IV/23 to V/2 | IV/26 to V/2 |
| Adults eclosed ... | V/11–29 | V/14 to VI/6 | V/1–? | V/6–? |
| Adults left cells . | V/14–31 | V/17 to VI/11 | V/3–13 | V/8–14 |

These ranges show considerable overlapping of dates. Actually, in any single nest containing both a chrysidid and vespid,

the chrysidid is almost always the first to pupate, eclose as an adult, and leave the nest. This difference may be only a day, or it may amount to nearly 4 weeks, depending on the sex and temperatures on the intervening days. The only exception to this above sequence occurred in C 700 where a male vespid in cell 8 and a female chrysidid in cell 7 developed simultaneously and emerged from the nest in that order on May 13.

Chrysidid males emerge earlier than the females; emergence dates were May 14 to 15 for three males and May 16 to 31 for six females in 1956, and May 3 to 7 for two males and May 13 for one female in 1957.

Vespid males also emerge earlier than females. This raises the question as to whether they might also emerge earlier than the chrysidid females and perhaps kill the latter in their efforts to leave the nest when the chrysidids are in cells closer to the entrance. Vespid males were present in only two of the nests under observation. In one nest (C 30) they walked out of their cells (3 and 5) immediately after eclosion on May 14, when I opened the nest for examination. Under normal circumstances they would have remained in their cells for several days longer until they were well hardened. A male chrysidid emerged from cell 7 on the same date. Also on May 14 a female chrysidid had transformed to an adult in cell 6 but was still in the cocoon; she did not leave the nest till May 19. In the other nest (C 700) a male vespid emerged from cell 8 on May 13, followed shortly by the female chrysidid from cell 7. The other cells contained female vespids which emerged May 22 to 29.

The pupal stage lasts, on an average, 14 days (range 9-16 days for five specimens) and about 4 more days (range 1-8 days for 11 specimens) are spent as adults in the cocoon after eclosion. The development of coloration in the pupae varies with prevailing temperature. The newly eclosed pupa is entirely pale ivory. The eyes darken through pale tan to black in 4 to 6 days. The entire body darkens in another 4 to 8 days. The adult ecloses from 4 to 6 days after the body darkens.

The chrysidid adults may cut their way out of the cocoon a day or two before they leave the boring. Such adults when they leave the cocoons are green or greenish-blue except for the nor-

mally concealed bases of the second and third abdominal terga which are dark blue. This green color is almost entirely replaced by dark blue in a very short time and the concealed bases of second and third terga become jet black.

**Chrysis (Chrysis) derivata** Buysson Fig. 7.

At Kill Devil Hills this species occurs only on the barrens. Dates of capture are: 1 ♂, June 26, 1954; 4 ♀♀, August 4-11, 1956. One female was taken on foligae of *Quercus falcata* covered with honeydew secretions of a species of *Phylloxera*, and three females were collected from the surface of planks in which the solitary vespid, *Rygchium molestum* (Saussure), was nesting. There is not necessarily any relationship between these two species; one specimen of *Chrysis* (*Pyria*) *fabricii* Mocsáry was also taken on one of these planks.

*C. derivata* is similar to *stenodyneri*, n. sp., in such details as sculpture, head and antennal proportions, and color. It may be separated by the fact that the edges of the apical emarginations of the third abdominal tergum are thin and beveled basad, instead of being thickened and sulcate as in *stenodyneri*. In addition, the male genitalia are distinct: in *derivata* the digitus is serrate on the basal half of ventral margin, the cuspis attains the apex of paramere, and the paramere dorsally is broad for most of its length and narrows abruptly to a short, apical digitate process; in *stenodyneri* the digitus is not serrate, the cuspis is not as long as the paramere, and the paramere tapers gradually and evenly toward the apex. The distribution of the two species is similar; the type of *derivata* is from Quebec, and I have seen specimens from New Hampshire, Massachusetts, New Jersey, Pennsylvania, Maryland, Illinois, and Missouri, as well as from North Carolina.

My interpretation of *derivata* is based on specimens so determined provisionally by L. H. Taylor. About the only diagnostic feature of value mentioned by du Buysson is the very short basal flagellar segments of the male type. Since he makes no reference to the apical margin of third tergum as being thickened, he probably had the species discussed here, rather than a specimen of *stenodyneri*, which also has the short basal flagellar segments.

It is possible that a specimen of *derivata* occupied a cell of a wooden trap nest (C 449) stored by an unknown solitary vespid. This nest had a 6.4 mm. boring and was tied to a dead branch of a scrubby *Q. virginiana* on the barrens 40 cm. above the ground in full sunlight. It was set out on July 22, 1955, and was completely stored by September 16. It was opened on September 26 and contained a dead miltogrammine fly and empty puparium and caterpillar remains in the first cell, a chrysidid larva spinning a cocoon in the second cell, and three empty cells between the second cell and the entrance. The chrysidid cocoon was ellipsoidal, 7 mm. long and 4.5 mm. wide, and of dense, opaque creamy silk. It was quite different in color, texture, and shape from the cocoons of *stenodyneri*. I opened the cocoon the following June 18 and found a dead, partly colored pupa. This individual had not been able to pupate completely and the abdominal venter was larviform. Development of other parts had proceeded enough so that I could determine it belonged to the subgenus *Chrysis* and had the head proportions and lateral margin of third tergum shaped as in females of *stenodyneri* and *derivata*. The edges of the emarginations of the third tergum appeared thin, though this may have been because development in that region was not complete. The shape and texture of the cocoon definitely eliminate *stenodyneri* from consideration. However, another trap (C 447) at this station was stored during this same period and was parasitized by *stenodyneri*.

**Chrysis (Pyria) fabricii** Mocsáry

This species occurs on the barrens and at the edges of wooded areas. Dates of capture in the field are as follows: 1 ♂, July 28, 1952; 1 ♂, June 28, 1954; 2 ♂♂, August 4 and 8, and 1 ♀, September 10, 1956. Two males were taken on foliage of scrubby *Quercus virginiana*.

I have reared this species from two wooden trap nests (C 673, 675) stored by the solitary vespid, *Rygchium megaera* (Lepeletier). The former nest had a boring of 4.8 mm. diameter, and the latter one of 6.4 mm. These traps were set out at the same station, horizontally beneath a dead willow branch on the barrens at the edge of the woods, 60 cm. above the ground. The

traps were exposed to full sun but the entrances were shaded during the day. These nests were stored between August 10 and September 9, 1956, and were opened on September 10.

Nest C 675, containing ten cells, was completely stored and all inhabitants were in the prepupal stage except in cell 7, where only lepidopterous larvae were found. There was a little agglutinated sand at the inner end of the boring and then ten cells, respectively 16, 12, 17, 15, 14, 13, 13, 13, 13 and 22 mm. in length. The sand partitions closing the cells were 1.5-2 mm. thick, except for that closing the terminal cell which was 5 mm. There were pale vespid pupae in cells 1 and 2 on April 23, and in cells 3-8 by April 26. The chrysidid pupae in 9 and 10 were all dark on April 29, while the vespid pupae in 1-8 were all dark except for appendages and apex of abdomen. On May 1 an adult had eclosed in 3, and there may have been adults in 9 and 10. Male and female *Chrysis fabricii* emerged from cells 9 and 10 on May 3 and 6, 1957—it is presumed that the male, which emerged first, came from cell 10. Male *Rygchium megaera* emerged from cells 4, 5, 6, and 8 on May 6 after the female chrysidid, and from cell 3 on May 7. The *megaera* adult males in cells 1 and 2 were dead by May 7, and apparently had not attempted to leave their cells.

Nest C 673 had an empty space of 80 mm. at the inner end and then a sand plug 2 mm. thick. Then there were three cells, 19, 17, and 16 mm. long, and the rest of the boring was empty. The inhabitants of all three cells were in the prepupal stage on September 10. A male of *Rychium megaera* emerged from cell 3 on May 6, 1957, and two females of *Chrysis fabricii* from cells 1 and 2 on May 8.

It is possible that nests C 675 and 673 were provisioned by the same female vespid, C 675 being stored first. This would be a plausible explanation for the fact that the last two cells of 675 and the first two cells of 673 were parasitized by a chrysidid. Another nest (C 674) with a 6.4 mm. diameter boring at the same station was stored by *Rygchium megaera* during the same period and contained prepupae on September 10. Three *megaera* males emerged from this trap on May 7, 1957 and four *megaera* females on May 10. The presence of both sexes of *megaera* and

absence of chrysidids suggest that this might have been the first of three nests stored by the same individual. Another reason for supposing that nests 674 and 675 were stored before 673, if all were stored by one individual, is that *megaera* prefers to nest in 6.4 mm. borings and apparently utilizes the 4.8 mm. borings only when no larger size is available.

Two of the chrysidid cocoons were preserved. Each is composed of two envelopes. The outer one adheres rather closely to the cell wall and is composed of pale, transparent silk on the posterior half and opaque, dense white silk on the anterior half. The inner cocoon is 7-8 mm. long, rather cylindrical with rounded ends, subopaque, and is composed of tan, varnished, rather brittle silk.

There are no other known host records for this species.

**Chrysis (Pyria) smaragdula** Fabricius

I captured one female, August 7, 1956, on foliage of scrubby *Quercus virginiana* on the barrens.

I have also reared a female from a wooden trap nest (C 288) having a boring 12.7 mm. in diameter. This trap was set out in a pile of wooden planks at the edge of the woods near the ground. It was completely stored between August 11 and September 9, 1956, by the solitary vespid, *Monobia quadridens* (Linnaeus). The nest contained four cells, the second of which was parasitized by the chrysidid. The *Monobia* larva in the third cell was preserved for taxonomic study. A male *Monobia* emerged from cell 4 on May 13, 1957, and the female chrysidid emerged from cell 2 on May 23. A female *Monobia* in cell 1 died May 28 just prior to eclosing as an adult.

This species spins a double cocoon. The outer irregular sheath is a pale tan, thin and brittle silken envelope 18 mm. long. The inner cocoon is dark tan, closely woven silk impregnated with varnish, rather brittle, almost opaque, ovoidal, 15 mm. long, and 7 mm. across the greatest width. The inner cocoon has a lining of pale, transparent, varnished silk which looks similar to the outer envelope.

There are no other known host records for this species.

**Parnopes westcottii atlanticus,** new subspecies

*Parnopes westcottii* Melander and Brues, a polytypic species, is separated from the other North American *Parnopes* by a combination of the small size (6.5-9.5 mm.), dense, appressed, silvery hair on lower two-thirds of front and sides of clypeus, notched mucro of postscutellum, and, in the female, longer spines of fore tarsal comb twice as long as apical width of tarsal segments. Typical *westcottii* (new status), which ranges from California to Texas and Iowa, has the tegulae, tibiae, and tarsi testaceous, the flagellum usually testaceous, the femora occasionally so, and most of the body bright brassy green frequently with some parts ferruginous or testaceous; *Parnopes diadema* Viereck, of which I have seen the male allotype and the single female paratype, both from the type locality, Florence, Ariz., is a synonym of typical *westcottii* (NEW SYNONYMY). The new subspecies, *w. atlanticus,* ranges along the coast from Maryland south to Florida, has only the outer margins of tegulae and the tarsi testaceous, and most of the body is dark blue or purple. There is a third subspecies, *w. taeniatus* Viereck (new status), in the Pacific northwest which has a body mostly blue, but retains the more extensive testaceous areas of typical *westcottii.* In *w. atlanticus* the postscutellum on each side of the mucro has rather sparse, silvery hair which does not obscure the sculpture, but in the other two races the sculpture is obscured by the dense, appressed, silvery hair. Frequently the mesopleuron in *w. westcottii* has similar dense, appressed hair but this is easily abraded; the mesopleuron of *w. atlanticus* is never so clothed.

*Type.*—♀ ; Kill Devil Hills, Dare Co., North Carolina; June 26, 1954 (K. V. Krombein; on flowers of *Cephalanthus occidentalis* on the barrens) [U. S. National Museum, Type No. 64203; by transfer from author's collection].

Length 7.7 mm. Forewing including tegula 5.5 mm. Head, thorax, and abdominal dorsum dark blue with purplish reflections, a central stripe on scutum, disk of scutellum, dorsum of mucro, and bases of second and third abdominal terga black. The following testaceous: margins of tegula broadly, bases and apices narrowly of all tibiae, fore tibia beneath, and all tarsi. Venter of abdomen and flagellum brown. Vestiture of vertex, thorax above, and abdomen above erect and silvery, longer on head; dense, appressed, silvery vestiture on sides of clypeus, lower two-thirds of front,

apical margins of first and second terga except median third, and similar but sparser vestiture on either side of mucro; the vestiture elsewhere scanty, pale, short and appressed. Forewing moderately infumated on apical half.

Female paratypes vary in length from 6.5 to 9.3 mm. A few of the specimens have slight greenish reflections, and in several the tectaceous margins of tegula are narrower, or the mucro may have some ferruginous.

*Allotype.*— ♂ ; same data as type, but June 30, 1954 [USNM].

Length 7.9 mm. Forewing including tegula 6.6 mm. Coloration and vestiture as in type, except margins of tegula more narrowly testaceous and base of fourth tergum black.

Male paratypes vary in length from 6.7 to 8.1 mm. The coloration is very similar to that of type except that several have a few greenish reflections.

*Paratypes.*—63 ♀♀, 15 ♂♂, all topotypical and collected by the author and with the following additional label data: 5 ♀♀, 3 ♂♂, July 3-20, 1950 (on flowers of *Cephalanthus occidentalis*); 2 ♀♀, 1 ♂, July 30-August 3, 1952 (two on foliage of *Quercus virginiana*); 53 ♀♀, 10 ♂♂, June 26-July 3, 1954 (on flowers of *Cephalanthus occidentalis*); 1 ♀, July 29, 1955; 1 ♂, August 4, and 2 ♀♀, September 10-11, 1956. Also 7 ♀♀, 1 ♂ as follows: 1 ♀, Wrightsville Beach, New Hanover Co., N. C., August 14, 1954 (T. B. Mitchell); 1 ♀, Southport, Brunswick Co., N. C., October 10, 1948 (C. W. Sabrosky); 2 ♀♀, Virginia Beach, Princess Anne Co., Va., August 11 and 14, 1913 (F. Knab); 1 ♀, Cape Henry, Princess Anne Co., Va., September 10 (J. N. Knull): 1 ♀, Chesapeake Beach, Calvert Co., Md., July 27, 1913 (R. C. Shannon); 1 ♀, 1 ♂, Plum Point, Calvert Co., Md., August 29, 1952 (K. V. Krombein). Paratypes are in the U. S. National Museum, Academy of Natural Sciences at Philadelphia, British Museum (Natural History), North Carolina State College, and in the personal collections of K. W. Cooper and the author.

I have seen a specimen, undoubtedly referable to *w. atlanticus*, from Fort George, Duval Co., Florida, July 17, 1883 (Pergande). So much of it has been destroyed by dermestids that it is not possible to be certain of the sex, though the coloration of the tegula indicates that it is a male.

*Biology.*—At Kill Devil Hills *Parnopes westcottii atlanticus* occurs only on the barrens, and the records from other localities suggest that it is confined to sandy soil in a narrow coastal area. It is partial to flowers of *Cephalanthus occidentalis* which it visits for nectar during the month-long blooming period. I have never collected it on other flowers, but I have taken it on foliage of *Quercus virginiana,* presumably visiting honeydew secretions, when *Cephalanthus* was no longer blooming.

Although several species of *Parnopes* are known to be parasitic on *Bembix,* Bohart and MacSwain (1940) have reared typical *westcottii* from cocoons of *Microbembex nigrifrons* (Prov.) (recorded as *M. aurata* Parker, a synonym) collected at Antioch, California. Circumstantial evidence points to *Microbembex monodonta* (Say) as the most likely host of *w. atlanticus* at Kill Devil Hills. In 1954 there was a colony of *Microbembex* on a sandy slope about 100 meters from one of the stands of *Cephalanthus* on which *Parnopes* was so common. I did not investigate a possible relationship between the two species until July 2 after I had captured a large number of *Parnopes* on the flowers. However, during the next 2 days I watched several *Parnopes* females investigating the *Microbembex* nesting site. Several examined the partially open entrances of some burrows, probably dug by male *Microbembex,* but they did not enter the burrows. Another female *Parnopes* was noted running on the ground and flying low over it in short flights; she dug in the sand several times but did not uncover any burrows. Once I saw a female *Microbembex* chase off a *Parnopes* that was investigating some partially open male (?) burrows.

Three species of *Bembix* occur at Kill Devil Hills, but none seems abundant enough to support such a population of *Parnopes.* Also, the somewhat smaller size of *atlanticus* as compared with other species of *Parnopes* suggests the likelihood of its having a smaller host such as *Microbembex.* The latter is one of the most common ground-nesting wasps on the barrens.

The lengthy seasonal flight period of *atlanticus* indicates that there are two or more generations a year. Adults from the overwintering population probably emerge late in June, for I did not see any *Parnopes* during my two visits to Kill Devil Hills in late

May and early June. A few *Microbembex* males were taken in late May, but the bulk of the overwintering population apparently is not on the wing until later in June.

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## Explanation of Figures

### Plate IX

Fig. 1.—*Chrysis* (*C.*) *stenodyneri,* new species. Female paratype (Kill Devil Hills, North Carolina). Frontal view of head. Fig. 1a.—*Idem.* Ventral view of third abdominal segment.

Fig. 2.—*Chrysis* (*C.*) *stenodyneri,* new species. Male paratype (Kill Devil Hills, North Carolina). Frontal view of head. Fig. 2a.—*Idem.* Ventral view of third abdominal segment.

Fig. 3.—*Chrysis* (*C.*) *laminifera* Bischoff. Female (Atlanta, Georgia). Frontal view of head.

Fig. 4.—*Chrysis* (*C.*) *alabamensis* Mocsáry. Female (Washington, D. C.). Frontal view of head.

(Figures 1-4 by Arthur D. Cushman, X 15.)

### Plate X

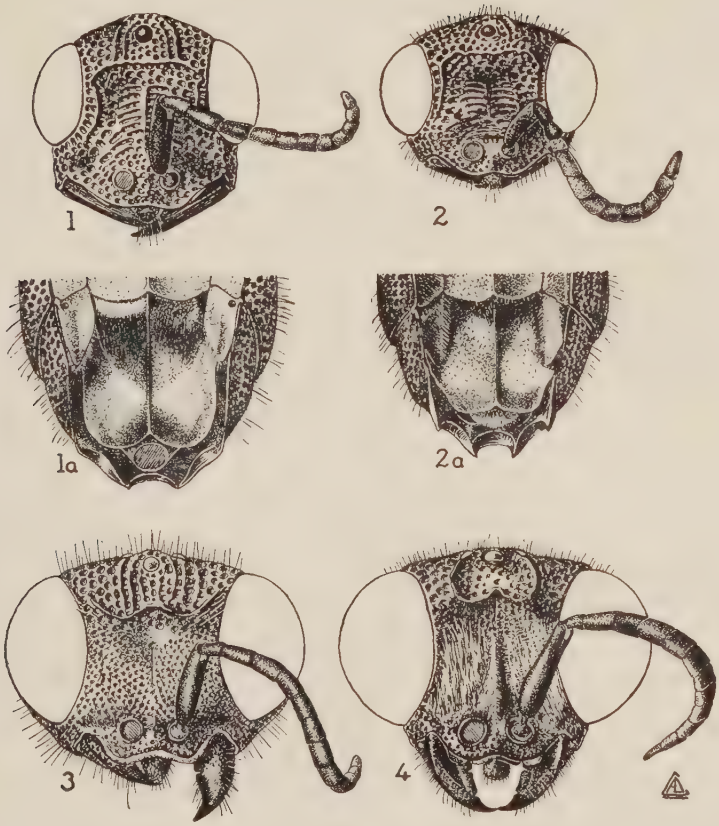
Fig. 5.—*Chrysis* (*C.*) *dorsalis* Aaron. Male (Hollister, Idaho). Genitalia somewhat flattened and dissected, ventral view at left, dorsal at right.

Fig. 6.—*Chrysis* (*C.*) *equidens* Viereck. Male (Kill Devil Hills, North Carolina). Genitalia, somewhat flattened and dissected, ventral view at left, dorsal at right.

Fig. 7.—*Chrysis* (*C.*) *derivata* Buysson. Male (Durham, New Hampshire). Genitalia, somewhat flattened and dissected, ventral view at left, dorsal at right.

Fig. 8.—*Chrysis* (*C.*) *stenodyneri,* new species. Male paratype (Kill Devil Hills, North Carolina). Genitalia, somewhat flattened and dissected, ventral view at left, dorsal at right.

(Figures 5-8 by author, X 60.)




KROMBEIN: CUCKOO-WASPS

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KROMBEIN: CUCKOO-WASPS

# THE TABANIDAE OF PENNSYLVANIA [1]

BY S. W. FROST

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The Tabanidae are especially common about animals or in wet, swampy areas and are generally known as horse and deer flies to the layman who has become conscious of them because of their bites. They are world wide in distribution and over twenty-five hundred species are known. About three hundred species occur in North America and seventy-three species have been taken in Pennsylvania.

Two major groups are generally recognized. The larger species which belong to the genus *Tabanus* have transparent, dark, or even black wings and are known as horse flies. The smaller species belonging to the genus *Chrysops* have distinctly marked or banded wings and are known as deer flies. The specialist recognizes the horseflies, *Tabanus*, by the fact that the hind tibia lack apical spines and the third antennal segment has a tooth-like process near the base. Other groups such as *Goniops*, *Stonomyia*, and *Atylotus* have no common names and include a relatively few species. Living specimens of tabanid flies often have bright-colored eyes spotted or banded with iridescent green or purple.

These flies are known in different parts of the world by many other common names such as gad flies, breeze flies, dog flies, ear flies, wood flies, mango flies, May flies, green heads, green eyes, ball heads, bull dogs, and clegs. In North America, horse flies and deer flies are the names generally used, although a species common in salt marshes is frequently referred to as green heads or green eyes.

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*Review of the literature.*—In 1875-1878 Osten Sacken's "Prodrome of a Monograph of the Tabanidae of the United States" appeared. This is the first detailed study of the Tabanidae of North America and includes several references to Pennsylvania species. Hine's "Second Report upon the Horseflies of Louisiana" in 1907 is a monumental work including notes on the life histories and habits of many species, some of which are known to occur in Pennsylvania. "Horseflies of Arkansas" by Schwardt in 1936 contributes a great deal to our knowledge of these species. However, only a few of these are known to occur in Pennsylvania. The "Report on the Tabanidae of Delaware" by MacCreary also adds considerable information to the habits of these flies, especially those inhabiting the coastal plain and salt marshes. "The Horseflies or Deerflies of California" by Middlekauff is an excellent summary of the western species but includes only three species known to occur in Pennsylvania, *Chrysops aestuans, Chrysops carbonaria* Walk, and *Tabanus lineola scutellaris* Walk. They have a wide range of distribution and are known from both the East and West.

During the past few years considerable interest in the Tabanidae has been aroused through their importance as pests of man and his animals, and the danger of these flies transmitting many diseases. It is well known that the dairy and animal industries of Pennsylvania are an important part of the agriculture of the State. The Tabanidae, along with other flies attacking cattle, deserve some vital consideration.

*Economic importance of the Tabanidae.*—Horse flies are undoubtedly serious pests. They torment man and his animals and are responsible for the transmission of certain diseases. They are aggressive blood suckers, weaken domestic animals, and reduce the production of milk. It is estimated that the daily loss of blood may be one-third of a quart when forty to fifty flies attack an animal. This does not take into account the blood that drips from the wounds after the flies attack. A medium-sized Tabanid takes about .2 cc. of blood for a meal.

In tropical portions of the world they are known to transmit anaplasmosis, anthrax, loa loa, and other diseases of animals. It has been established that *Tabanus sulcifrons,* a common species

in Pennsylvania, by interrupted feeding was capable of transmitting anaplasmosis of cattle.

*Tularemia* is an infectious disease caused by *Bacterium tularense* (*Pasteurella tularemia*). Primarily it occurs in nature as a plague-like disease of rodents, especially rabbits and hares. It is transmitted to man by several blood-sucking insects. Various workers have demonstrated that *Chrysops discalis* may transmit this disease from infected to healthy guinea pigs and rabbits. The method of transmission was purely mechanical although the fly could remain infective as long as fourteen days. It has also been demonstrated that numerous human cases of Tularemia were due to the bite of this fly, the fly obtaining the bacterium from jack rabbits and transmitting the disease to man. Cases due to the bite of *Chrysops discalis* have been reported from Utah, Idaho, Wyoming, Colorado, Oregon, and Montana.

*Methods of obtaining data.*—Eggs and larvae were obtained by visiting breeding areas. They were sought chiefly in damp places, on plants such as cat tails, spatter dock, and grasses. They may occasionally be found on bridges and the leaves or the bark of trees. The collection of larvae was a laborious task. They were generally found in mud at the edges of the breeding areas and were secured by using a home made screen. A wooden frame about two or three inches deep and fourteen inches square is satisfactory. This is covered with 12-mesh screen and reinforced with 1/4 inch hardware wire. The mud is placed on the screen which is partially submerged in the water and is gently agitated until the mud is washed away leaving the trash and the larvae which can, with diligence, be located.

Adults were obtained in many ways. Collecting with an insect net in the proper places contributed the largest number. Species that rest upon stones, foliage, or mud were sought. Those that have a habit of hovering, such as *Tabanus affinis* and *cinctus,* were not overlooked. Species that attack man were obtained by swinging the net about the head, however this method generally yielded only females.

Collecting adults from cattle has not been very productive. It was difficult to approach animals in the field and some

farmers objected as it frequently disturbed the cattle.

Numerous Tabanidae have been gathered in barns. In poorly regulated barns the adults flew towards the windows and were picked up in large numbers. In better regulated barns flies were few. Such barns often were ventilated and the adults flew out the windows. However, specimens were frequently found on the sills of the windows sometimes trapped in spider webs. Even when killed with insect sprays they were frequently found in webs. These do not make fine specimens but could be reconditioned to give records of species known to visit barns or attack cattle.

Many species were attracted to light. They yielded a large percentage of males which were generally difficult to collect. MacCreary (1940) took four hundred twelve specimens and seven species from various light traps operated in Delaware. Frost (1953) took seventeen additional species from a single light trap operated one season in Pennsylvania. When traps are placed close to the breeding areas, large numbers of these flies can be expected and it seems to be an excellent method of obtaining males.

*Tabanidae taken at lights.—Goniops chrysocoma,* the only species of this genus, occasionally has been taken at light.

Seven species of the genus Chrysops was recorded by the senior author (1953). Eight additional species may be added chiefly through the efforts of the junior author as follows—*carbonaria, dimmocki, frigida, inda, lateralis, shermani, univittata,* and *wiedemanni.* Of these, only *C. geminata* and *C. wiedemanni* were strongly attracted to light. *C. vittata* was taken several times in moderate numbers.

*Chrysozona rara,* the only Pennsylvania species, was taken occasionally at light.

*Atylotus bicolor* was reported in 1953. *A. ohioensis* and *A. thoracicus* have subsequently been taken.

Species of the group *Hybomitra* apparently are not strongly attracted to light. *T. lasiopthalmus* was reported in 1953. *Tabanus hinei, microcephalus,* and *typhus* can be added to the list of species occasionally attracted to light.

Some species of the group Tabanus are strongly attracted to

light. Six were reported in 1953. To these can be added twelve observed chiefly by the junior author, *T. atratus, calens, catenatus, fulvulus, lineola, melanocerus, nigrescens, nigripes, reinwardti, sackeni, sagax,* and *sparus.* Of these, only *T. catenatus, fulvulus, lineola, sackeni, sagax,* and *sparus* were strongly attracted.

*Tabanidae taken in baits.*—Many species have been trapped in liquid baits. Such baits are often used for trapping codling moths and oriental fruit moths. MacCreary (1940) mentions three species—*Tabanus americanus, T. atratus,* and *T. stygius*—which were taken from codling moth baits. Frost (1936) took three hundred thirty-three Tabanidae from bait traps operated for oriental fruit moths. Twenty-five per cent of these were males. These records added six additional species known to visit baits, namely *Tabanus lasiopthalmus, T. sulcifrons, T. giganteus, T. nigrescens, T. lineola,* and *T. quinquevittatus.* Material trapped in baits can be cleaned with alcohol and yield specimens satisfactory for records.

*Contributing collections and collectors.*—The collections of the Academy of Natural Sciences of Philadelphia; the Carnegie Museum, Pittsburgh; the University of Pittsburgh; The Bureau of Plant Industry, Harrisburg; the Department of Zoology-Entomology, The Pennsylvania State University; and the extensive collection of the junior author have been consulted. Most of the material in the Harrisburg collection was identified by C. B. Philip and that in the Carnegie Museum by George E. Wallace. All of the material has been subsequently studied by Dr. L. L. Pechuman.

Numerous individuals have collected specimens or contributed records. Their names are given as a foot note to the list of Tabanidae known to occur in Pennsylvania. Certain of these deserve special mention. George E. Wallace of the Carnegie Museum, Harold J. Grant Jr. of the Academy of Natural Sciences of Philadelphia, and Ralph B. Priddy of the University of Pittsburgh were unusually helpful in contributing records and loaning material for study.

*General Habits of the Tabanidae.*—The females of most Pennsylvania species are blood suckers and require a meal of

blood before they can lay eggs. Both males and females feed on sweetened juices such as honey dew, exudations of plants, or nectar, hence frequently are found on flowers or attracted to baits.

It is known that the adults of certain species of tabanids are associated with definite flowers. Stone (1930) took five specimens of *Stonomyia rasa,* all in his collection, from *Daucus carota.* The junior author reports many specimens of both sexes of this species from the same flowers but took them more rarely on those of *Eupatorium.* Males and females of *Stonomyia tranquilla* were taken in large numbers on *Spiraea latifolia.* Males of *Chrysops lateralis* and *C. frigida* and both males and females of *Tabanus trispilus* were taken in considerable numbers on *Spiraea latifolia* although none were taken on *Spiraea tomentosa* growing nearby. He took males of *Chrysops geminata* and *C. lateralis* and both males and females of *Tabanus trispilus* on *Ceanothus americanus.*

As previously mentioned, many species are attracted to light. They have been taken at light houses, in light traps, and at neon lights near fruit and ice cream stands.

In general the adults are powerful fliers and the large species can travel long distances. They frequently follow moving objects such as automobiles and trains keeping pace with them. They are especially active on warm sunny days. During cool periods and during the evening they usually rest upon the foliage or trunks of trees. The deer flies have a habit of flying about man's head as well as that of other animals, biting the neck or head. The piercing action is powerful, temporarily painful, but seldom accompanied with inflammation or prolonged swelling.

Some adults have unusual habits. *Tabanus affinis,* a moderate-sized species, has the habit of hovering in groups in sunny spots in the dense woods and may be mistaken for syrphid flies which are known as hover flies and have similar habits. *Tabanus cinctus* and *Tabanus trispilus* are also known to hover in the sunshine above the treetops where it is difficult to obtain them. *Goniops chrysocoma* lays its eggs on the undersides of the leaves of maples. The female then takes a position over the eggs and broods much like a hen. Here she remains until she dies.

Horse flies commonly breed in wet areas such as marshes, swamps, bogs, and ponds—especially where there is considerable vegetation. The adults are more troublesome in and about such places. It is in these areas that the eggs are usually deposited and the larvae live.

The eggs are pale when laid and usually darken to brown or black. They generally are laid in compact masses varying considerably in size and shape. The female oviposits on plants and other objects often above the surface of the water. In many cases she seems to select specific plants. MacCreary (1940) states that *Tabanus lineola* prefers grasses such as *Spartina* and *Scirpus*. Other species select hibiscus, maple, spatter dock, and cat tail. Certain species prefer to oviposit on plants growing on moist ground. Since the larvae of *Tabanus quinquevittatus* have been found in dry ground, it may be presumed that oviposition takes place over this habitat.

When the eggs hatch the larvae usually drop to the water. They are legless and vary much in shape and coloration. The larvae of *Tabanus atratus* is distinctly marked and frequently illustrated in literature. The larvae live in water, soft damp soil, under stones, in mud, or in wet rotting logs. Most of the species are found in the water, in the mud at the bottom of swamps or ponds. The pupae are dull yellowish with an encircling row of stiff hairs on the apical third of each segment and a group of short fleshy proturberances at the posterior end.

*Pennsylvania as an ecological unit.*—Pennsylvania is a large state comprising approximately 50,000 square miles, 1,800,000 acres of forest lands, and extensive crop areas. It has a diversified topography varying from sea level to 3213 feet. Since the habits of the Tabanidae are chiefly aquatic, these areas are important.

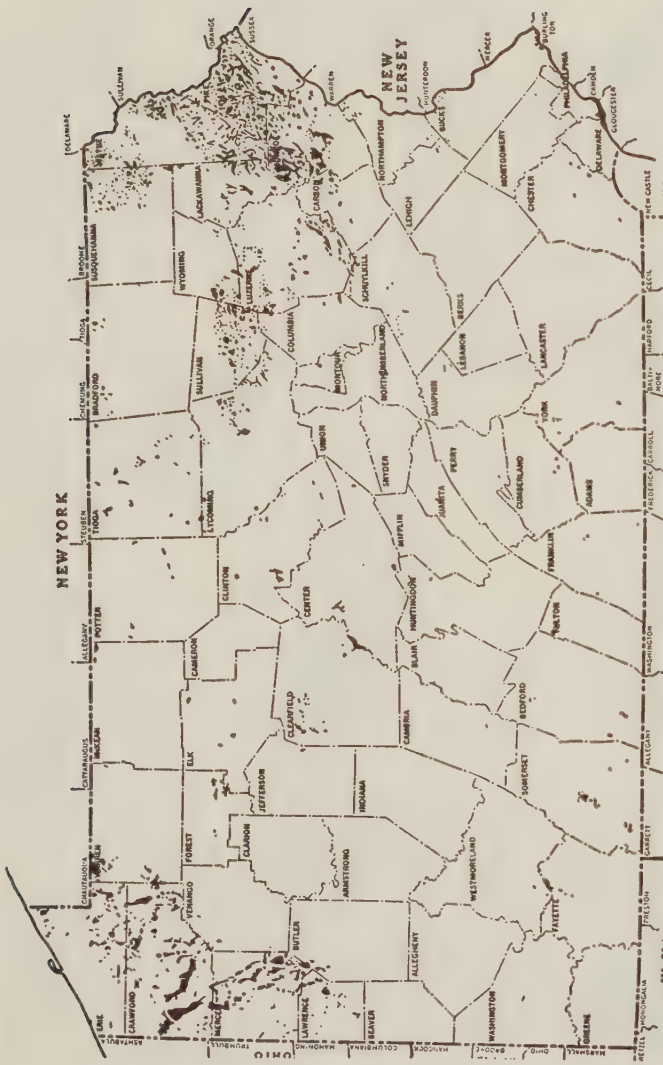
Pennsylvania has an extensive system of streams. Approximately two thousand streams cut the mountainous areas forming many valleys and eventually reach the Atlantic. Those of eastern Pennsylvania flow into the Susquehanna. Those of western Pennsylvania flow into the Ohio and Mississippi. A small area in north central Pennsylvania and the Lake Erie area drain into the St. Lawrence.

There are over two hundred fifty natural lakes exceeding 20 acres in extent. Conneaut Lake, Crawford County, is the largest with an area of 928½ acres. Harvey Lake, Luzerne County, is the next largest, about 658½ acres. The artificial lakes of the state, such as Pymatuning in Crawford and Wallenpaupac in Pike County, far exceed in size the natural lakes. Ponds are numerous throughout the state, many having been made rather recently.

The marshes and swamps are the most extensive habitats for Tabanidae in Pennsylvania. The accompanying map (map 1) of the swamps of Pennsylvania was compiled from U. S. topographic sheets. Many, such as those of the Pymatuning and Wallenpaupac areas, have been dammed since the original maps were made and now appear as lakes. The swamp areas coincide to a large degree with the glaciated areas of the state. Bogs are few. The most extensive bogs are those of the higher elevations and those occurring in the glaciated areas of the state. Bear Meadows, Centre County, is well known to most biologists. Tamarack bog, Clinton County, has been considerably altered by lumbering but tamaracks, cranberries, pitcher plants, and sphagnum still grow abundantly.

A few species have been selected to illustrate the key position occupied by Pennsylvania. The distribution of these is shown in text-figure 1. *Chrysops aberrans, C. aestuans, C. frigida, C. lateralis, Tabanus* (*Hybomitra*) *minisculus, and T.* (*H.*) *zonalis* are typical northern species. *Chrysops fulvulus* and *Tabanus* (*T.*) *sparus mileri* are typical southern species.

*Color patterns of the eyes.*—The maculations of the eyes of the Tabanidae often aid in identification. They are briefly referred to by Osten Sacken (1875-78) and by Hine (1907). Daecke (1906) describes and figures the eye-patterns of many species of Chrysops. He points out that considerable variation exists. He did not indicate the angle from which the sketches were made but apparently they are lateral views of the left eye. The sketches included in our paper are front views of the right eye (Plate XI).




Map. 1.—The swamp areas of Pennsylvania. (Compiled by William and R. R. Brown.)

Text-figure 1.—Maps illustrating the distribution of typical northern and southern tabanid species in northeastern North America. (1) *Chrysops aestuans* van der Wulp; (2) *Chrysops frigida* O.S.; (3) *Chrysops lateralis* Wied.; (4) *Tabanus* (*H.*) *miniscula* Hine; (5) *Tabanus* (*H.*) *zonalis* Kirby; (6) *Chrysops aberrans* Philip; (7) *Tabanus* (*T.*) *fulvulus* Wied.; (8) *Tabanus* (*T.*) *sparus milleri* Whitney.

The patterns are conspicuous and beautiful in fresh material but disappear when the insect dies. The color can be restored by placing the specimen in a relaxing jar for twelve or twenty-four hours. The patterns should be studies under subdued light, preferably with a black background. The ground color of the eye is generally green superimposed with a pattern of brown or dark purple. Species of the genus *Tabanus* usually have bars or stripes while those of the genus *Chrysops* have spots. The patterns of the genus *Tabanus* are more constant and useful in making determinations. In the male of many species the facets of the upper portion, or about three quarters of the eye, are large and coarse while those of the lower portion are small and fine. The color patterns are often distinct on the lower part of the eye but obscure or absent on the upper part. In the male of *Chrysops* the lower portion of the eye shows the characteristic pattern of the female eye.

*Wing patterns.*—The wings of the Tabanidae are often marked in some fashion (Plate XII). This is especially true of the genus *Chrysops*. These patterns have been figured by various workers and have been used to a considerable extent to identify species.

*Species common in Pennsylvania.*—About twelve species are generally common in Pennsylvania and include those that freely attack man and other animals. Collections made during the summer of 1957 give a fair idea of the abundance of these species. All were collected from thirteen counties in the northern and north eastern part of Pennsylvania—areas where little or no collecting has been done previously. The following table (table 1) summarizes the abundance of these species. Although *C. geminata, T. typhus,* and *T. pumilus* do not occur in this table there is evidence that they are also common. Not more than 15 specimens of each were collected during 1957 but they were taken from a wide area—*C. geminata* for example from 16 counties during the past few years.

Table 1. Species of Tabanidae taken most frequently in Pennsylvania

| Species | No. specimens taken in 1957 | No. counties represented in 1957 | Total No. counties represented |
|---|---|---|---|
| *C. callida* | 192 | 12 | 21 |
| *C. vittata* | 85 | 10 | 34 |
| *C. shermani* | 70 | 5 | 7 |
| *C. inda* | 66 | 5 | 20 |
| *C. nigra* | 54 | 9 | 30 |
| *C. univittata* | 31 | 8 | 33 |
| *T. difficilis* | 30 | 7 | 23 |
| *T. lasiopthalmus* | 48 | 7 | 24 |
| *T. lineola scutellaris* | 27 | 7 | 15 |
| *T. quinquevittatus* | 118 | 11 | 26 |
| *T. sulcifrons* | 55 | 8 | 26 |

*A discussion of the common economic species.—Chrysops callida* O. S. This is without doubt the most common species of Chrysops in Pennsylvania. It is widely distributed throughout the state and frequently attacks man, horses, mules, and cattle. The species ranges from Ontario and Montreal west to Arkansas and Michigan and south to Florida. It has been taken in twenty-one counties in Pennsylvania, frequently in large numbers. Eggs are common during the early part of the summer upon grasses above the water. Larvae were obtained in considerable numbers from muddy areas adjacent to ponds. The adults are on the wing from late May until early August.

*Chrysops shermani* Hine is seldom mentioned in the economic reports on the Tabanidae but is common in Pennsylvania and frequently attacks man. This species is easy to identify because of the clouded areas between the veins of the wings. It ranges from New Brunswick, Quebec, and Ontario west to Wisconsin and Michigan, and south to Georgia. Apparently it is more common in Pennsylvania than the adjoining states. Although common, it has been taken from only seven counties and seems to occur chiefly in mountainous areas. This species is most troublesome during the middle of the summer—chiefly during June and July.

Table 2. Animals attacked by Pennsylvania species of Tabanidae

| Species | Man | Cattle | Horses & mules |
|---|---|---|---|
| *C. aestuans* VdW. | X | | |
| *C. callida* O. S. | X | X | X |
| *C. carbonaria* Walk. | X | X | X |
| *C. celer* O. S. | X | X | X |
| *C. dimmocki* Hine | X | X | X |
| *C. geminata* Wied. | X | | |
| *C. inda* O. S. | X | X | X |
| *C. moecha* Macq. | X | X | |
| *C. montana* O. S. | X | | |
| *C. nigra* Macq. | X | X | X |
| *C. sackeni* Hine. | X | | |
| *C. shermani* Hine. | X | | |
| *C. univittata* Macq. | X | X | |
| *C. vittata* Wied. | X | | |
| *C. wiedmanni* Krober | X | X | |
| *T. atratus* Fab. | | X | X |
| *T. difficilis* Wied. | X | | |
| *T. fulvulus* Wied. | X | | X |
| *T. hinei* Johnson | X | | X |
| *T. illotus* O. S. | X | | X |
| *T. lasiopthalmus* Macq. | | X | X |
| *T. lineola* Fab. | X | X | X |
| *T. lineola scutellaris* Walk. | X | X | X |
| *T. melanocerus* Wied. | | X | X |
| *T. nigripes* Wied. | X | X | |
| *T. nivosus* O. S. | X | X | X |
| *T. pumilis* Macq. | X | | |
| *T. quinquevittatus* Wied. | | X | X |
| *T. recedens* Walk. | | X | |
| *T. reinwardti* Wied. | | X | |
| *T. sparus* Whitney | X | X | |
| *T. sparus milleri* Whitney | X | | X |
| *T. sulcifrons* Macq. | | X | X |
| *T. superjumentarius* Whitney | | X | X |
| *T. trepidus* McD. | X | | |
| *T. trimaculatus* P.d.B. | | X | X |
| *T. trispilus* Wied. | | X | X |
| *T. typhus* Whitney | X | X | X |

*Chrysops vittata* Wied. is another common species in Pennsylvania, often causing discomfort to man and attacking horses and cattle. It is generally common in the central and eastern states and ranges from Quebec to Florida. It is reported rare in Arkansas but common in Michigan. It has been taken in thirty-four counties in Pennsylvania and is rated as one of the economic forms. Males and females have been taken in light traps. The adults are abundant from late June until the end of August.

*Chrysops inda* O.S. rates about third in importance in Pennsylvania. It is often abundant, widely distributed, and a persistent pest of man, horses, and cattle. This species ranges from Ontario and Montreal to Quebec and south to Georgia and appears to be more common in the northern portion of its range. It has been taken in twenty counties in Pennsylvania and is generally abundant.

*Chrysops nigra* Macq. is another common species of Pennsylvania which attacks man, horses, and cattle. It ranges from Newfoundland, Montreal, and Ontario west to Minnesota and Oklahoma and south to Florida. It is widely distributed in Pennsylvania and has been taken in thirty counties. Two females have been taken at light.

*Chrysops univittata* Macq. is probably more important than generally realized. It is not an agressive species but attacks man and cattle and is often abundant. Its distribution is limited to central and eastern United States and is known from Kansas and Nebraska throughout the eastern states from Connecticut to Florida. It has been taken in thirty-three counties in Pennsylvania and usually captured in the act of biting. It is one of the early appearing species and has been found from late May until early August.

*Chrysops celer* O. S. attacks man and cattle. It is generally distributed throughout the central and eastern states and ranges from Quebec and Montreal south to Georgia. It has been taken in fifteen counties in Pennsylvania—often in considerable numbers.

*Chrysops carbonaria* Walk. is often common, attacks man and cattle and should be included among the economic forms. There

are two forms in Pennsylvania (1) those with dark wing markings in which the cross band has a straight outer margin and reaches the margin of the wing and (2) those with lighter wing markings in which the cross band has an irregular outer margin and barely, or not at all, reaches the wing margin. Both forms are equally as abundant in Pennsylvania. This species is widely distributed in Canada and the United States. In Pennsylvania it has been taken from ten counties.

*Tabanus lasiopthalmus* Macq. is a widely distributed species known from Alberta to Quebec, through the central and eastern states south to Georgia. In Pennsylvania it is one of the most common species and has been taken in twenty-four counties. It superficially resembles *T. sulcifrons* in appearance with a brownish abdomen and with the furcation and cross veins margined with brown which gives the wings a spotted appearance. The eyes of the female, in fresh specimens, have four narrow green bands. *T. lasiopthalmus*, however, is considerably smaller in size and the wings are almost entirely without a brownish tinge. Adults have often been taken in light traps, in liquid baits, in barns, and other shelters. It is an early species and is found from the middle of May to the middle of July.

*Tabanus sulcifrons* Macq. is another abundant and important species that attacks cattle in Pennsylvania. It is a medium-sized species. The females are vicious biters and the cause of considerable restlessness in cattle that are not properly sprayed. The wings usually have a distinct brownish tinge and the cross veins and furcation of the third are margined with darker brown. The eyes of the female have two narrow greenish bands. It ranges from Iowa and Michigan, east to New York and south to Oklahoma and Florida. It has been taken in twenty-six counties in Pennsylvania and is often present in large numbers. This species frequently enters barns and buildings. The adults are often encountered in wooded areas about streams or marshes. They rest upon vegetation, stones, reeds, or mud banks. On one occasion twenty males were at rest or flying about the water. They have a habit of dropping to the surface, hitting the water, then darting away. Adults are freely attracted to lights. Eleven males and thirty-eight females were taken in a single

light trap operated from May 15 to September 15. They are also attracted to liquid baits. About 75 per cent of the catches are females which are often engorged with blood. This species is more common during late summer, especially August, but may be found from June 1 to September 1. It is closely related to *T. abdominalis* and has been confused with it. Although a number of Pennsylvania specimens of *sulcifrons* studied approached *abdominalis,* none of them could be determined definitely as *abdominalis.*

*Tabanus lineola scutellaris* Walk. is another common species frequently imprisoned in barns, buildings, and cars. They often attack cattle, especially the udders. This species has a wide range of distribution—from British Columbia and California east to Massachusetts and south to Georgia. Records have been considerably confused in literature but it has been definitely reported from thirty states and has been taken in fifteen counties in Pennsylvania where it is generally common. Adults are on the wing from the first of June to the end of August.

*Tabanus atratus* Fab. is the largest of the horse flies and because of its size is probably the best known. It is a black species with dark brown or even black wings. They are vicious biters and can consume a considerable amount of blood. It occurs throughout most of the states east of the Rockies—from Idaho and New Mexico, east to Ontario and Massachusetts, and south to Florida. It seems to be more common in the southern part of its range. Although often associated with cattle it is not a common species in Pennsylvania. Adults have been taken in liquid baits from June 1 to September 13. They are known to be attracted by moving objects, especially autos, which they follow for miles. The larva is likewise well known because of its size and distinct dark markings.

*Tabanus quinquevittatus* Wied. (=*vicarius* Walk., *costalis* Wied.) is a relatively small but important species in Pennsylvania, attacking man and cattle. It is common in the central and eastern states ranging from Michigan east to Maine and south to Florida. It has been taken in twenty-six counties in Pennsylvania where it is often abundant. This species is also abundant in the adjoining states, New York and Delaware.

Males and females have been taken in light traps. Adults are also frequently found in barns and buildings.

*Tabanus difficilis* Wied. (= *carolinensis* of authors) is another of the smaller species of the genus Tabanus that frequently attacks man. It is known from Michigan east to Massachusetts and south to Oklahoma and Georgia. It has been taken in twenty-four counties in Pennsylvania where it is frequently very numerous and apparently more important than in some of the adjoining states. Adults have been collected from May 25 to July 25.

*Tabanus pumilus* Macq. is one of the smallest of the genus Tabanus, scarcely larger than a housefly, and frequently attacks man. It occurs from Maine to Florida and west to Arkansas and Michigan. It is abundant throughout Pennsylvania and has been taken in eleven counties. In New York State it is reported to be abundant but not so in Delaware. Males and females have frequently been taken in light traps. This species may be found from June 6 to August 12.

*Tabanus reinwardti* Wied. seems to have been taken more frequently in Pennsylvania than in the adjoining states. Although it has been found in barns and shelters most workers state that it is a rare species and does not attack horses or cattle. It is reported from Alberta to Nova Scotia and south to Colorado, Michigan, Arkansas, and Georgia. All records indicate that the larvae are more common than the adults. In Pennsylvania it has been taken in thirteen counties.

*Tabanidae known to occur in Pennsylvania.*[2]

*Stonomyia isabellinus* (Wied.) (= *pigra* O.S.): ADAMS, Arendtsville, July 31 (SWF); CUMBERLAND, Carlisle Jc., July 4; DAUPHIN, Dauphin, June 24, July 3 (ABC), June 25; PHILADELPHIA, Germantown, July 18.

*Stonomyia rasa* (Loew): ALLEGHENY, Gibsonia, Aug. 7 (GEW), Culmerville, Aug. 12 (GEW), Aug. 30 (HK); COLUMBIA, Aug. 13 (HK); DAUPHIN, Speeceville, June 13 (JHN); FOREST, Endeavor, June 30 (HBK); MONROE, Pocono Lake, July 12; PIKE, Milford, July 29 (R. Rauch).

*Stonomyia tranquilla* (O.S.): FOREST, Endeavor, July 30 (HBK); MONROE, Pocono Lake, July 13, 14; PIKE, Keene Lake, July 24 (SWF); SULLIVAN, Ricketts Glen, Aug. 20 (SWF).

*Goniops chrysocoma* (O.S.): ALLEGHENY, Pittsburgh, May 18, Nadine, July 29, Wilmerding Aug. 22; CENTRE, Fillmore, July 2 (Ford), Penn. Rsvlt. Dam, July 9 (SWF); CLEARFIELD, Kyler's Corners, July 29 (GHB); DAUPHIN, Clarks Valley, June 29, Hummelstown, June 10, July 1 (JNK), Rush Township, June 29 (ABC); HUNTINGDON, Charter Oak, July 9 (HBK-ABC); LANCASTER, Accomac; LYCOMING, Wallace Run, July 27 (HBK); WESTMORELAND, Jeanette, Powder Mill, Aug. 3 (R-C).

*Chrysops aberrans* Philip: ALLEGHENY, Pittsburgh, June 2 (HK); CLEARFIELD, Curwensville, June 25; CRAWFORD, Conneaut Lake, Aug. 6 (HK), Linesville, June 11-13, 16, 20, July 13 (RBP), Pymatuning, June 26; DAUPHIN, Harrisburg, June 26 (JNK-ABC).

*Chrysops aestuans* van der Wulp: ERIE, Presque Isle, July 7, 15-19, 29, 31, Aug. 3, July 3 (McI), June 18 (SWF), July 15, 17 (LLP).

*Chrysops beameri* Brennan: ADAM, York Springs, Aug. 9 (SWF).

*Chrysops callida* O.S.: ALLEGHENY, Gibsonia, June 13, July 19 (GEW), Harmarville, June 24 (HK), North Park, June 7 (RBP); BEAVER, New Galilee, June 22; BRADFORD, Beaver Dam, July 17 (SWF); BUCKS, Falsington, July (JAC), Perkasie June 18; BUTLER, Portersville, June 28 (GEW-CWS); CENTRE, Barrens, June 10, 11, 16, 25-28, July 1-3 (SWF), June 23 (VRH), Beaver Dam, June 3, 4, 6, 10, 13, 20, 22, July 4, 16, 17, 30 (SWF), Black Moshannon, June 13, 22, 24, 27, July 2, 4-6, 14 (SWF), Bear Meadows, June 24 (SWF), Fillmore, June 17 (SWF), States College, June 22 (SWF), The Rock, June 13 (SWF); CLINTON, Sugar Run, June 7, 19 (RLC); CRAWFORD, Linesville, June 12, 13, 18,

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[2] Collectors of Tabanidae, indicated by initials: C. S. Anderson (CSA), John Bauer (JB), G. H. Beatty (GHB), R. R. Brown (RRB), R. L. Campbell (RLC), A. B. Champlain (ABC), J. A. Chemsak (JAC), H. K. Clench (C), Erich Daecke (ED), S. W. Frost (SWF), George M. Green (GMG), T. L. Guyton (TLG), V. R. Haber (VRH), H. Kahl (HK), H. B. Kirk (HBK), J. N. Knull (JNK), W. D. McIllroy (McI), L. L. Pechuman (LLP), Ralph B. Priddy (RBP), N. D. Richmond (R), J. G. Saunders (JGS), C. W. Stafford (CWS), W. R. Walton (WRW), G. E. Wallace (GEW).

24, July 27 (RBP), June 25 (SWF), Mud Lake, Aug. 4, Pymatuning, June 26 (SWF); CUMBERLAND, Mt. Holly, June 23 (ABC), West Fairview, July 21; DAUPHIN, Harrisburg, June 12, 28 (HBK), June 4, 6, 25, July 10, Hummelstown, June 15 (JNK), Progress, June 11 (HPBailey); ELK, Medix Run, June 6 (SWF); ERIE, Presque Isle, July 15 (LLP), July 31 (GEW); FAYETTE, Dunbar, June 10, Indian Cr. Resevoir, Aug. 13 (SWF); FOREST, Tionesta, June 25 (SWF); HUNTINGDON, Huntingdon, April 29, Whipple Dam, July 17 (SWF); MERCER, Pymatuning Lake, June 5 (SWF); MONROE, Delaware Water Gap; PHILADELPHIA, Olney, June 17; SULLIVAN, Lake Mokoma, July 17 (GHB); TIOGA, Bradley Wales, July 3 (SWF); VENANGO, Drake Well Pk., June 22 (RRB).

*Chrysops carbonaria* Walker: ALLEGHENY, Pittsburgh, June 4; BUTLER, Portersville, June 28 (GEW); CENTRE, Barrens, June 18 (SWF), Bear Meadows, June 10, July 15 (SWF), Beaver Dam, June 13, 20, 27 (SWF), Black Moshannon, July 6 (SWF), Milheim, July 3, Penn. Rsvlt. Dam, May 20, 30 (SWF), The Rock, May 30, June 13 (SWF), State College, May 17, June 1 (SWF), June 11 (RRB); CLEARFIELD, Shawville, June 15, 21 (JB); CLINTON, Sugar Run, June 14 (RLC); HUNTINGDON, Greenwood Furnace (SWF); SOMERSET, Mt. Davis, June 10 (C); SULLIVAN, Lake Mokoma, June 17, 29 (GHB), Ricketts Glen, June 17 (SWF); WESTMORELAND, Powder Mill, May 12 (R), Near Rector, July 18 (A. C. Lloyd); TIOGA, Bradley Wales, July 3 (SWF).

*Chrysops celer* O.S.: ALLEGHENY, North Park, June 7 (RBP); BUCKS, Perkasie, June 18; CENTRE, Barrens, June 11, 26 (SWF), Bear Meadows, June 10, 25 (SWF), Beaver Dam, June 6, 13, 27 (SWF), Black Moshannon, June 22, July 6 (SWF), Fillmore, June 19 (SWF), Gap Run, June 25 (SWF), Penn. Rsvlt. Dam, June 19 (SWF), State College, May 19, June 10, 15, 18 (SWF), The Rock, May 28, June 2, 13, 14, 20, 22, 29 (SWF); CLEARFIELD, Shawville, April 20, May 1, June 9, 17-21 (JB); CLINTON, Sugar Run, June 14, July 5 (RLC), Tamarack, June 25, 30 (SWF); CRAWFORD, Linesville, June 11, 12 (RBP); CUMBERLAND, Enola, June 7; DAUPHIN, Clarks Valley, June 20 (CSA), July 12 (ABC), Harrisburg, May 30, June 7 (HBK), Hecton Mills, June 15 (HDBailey), Inglenook, May 21 (ABC), Lingletown, May 21 (ABC), May 1, April 20; FAYETTE, Indian Cr. Resevoir, June 13 (SWF); HUNTINGDON, Charter Oak, July 5 (JNK), Spruce Creek, June 22 (SWF); MONTGOMERY, Glenside, May 30 (ED); POTTER, Ole Bull, June 25 (SWF); SOMERSET, Mt. Davis, June 10 (C); SULLIVAN, Lake Mokoma, June 17 (GHB); UNION, Halfway Park, June 19 (SWF).

*Chrysops cuclux* Whitney: ALLEGHENY, Gibsonia, May 30 (GEW); CENTRE, The Rock, May 30 (SWF); CRAWFORD, Linesville, June 14 (RBP); DAUPHIN, Clarks Valley, May 23, 30 (ABC), Inglenook, May 31 (ED), May 19, June 1; HUNTINGDON, Spruce Creek, June 22 (SWF); LEBANON, Lotell, June 12.

*Chrysops dacne* Philip: CRAWFORD, July 26 (McI); DAUPHIN, Harrisburg, June 26 (ED).

*Chrysops dimmocki* Hine: BUCKS, Perkasie, June 18; CRAWFORD, Linesville, June 11 (RBP).

*Chrysops frigida* O.S.: CENTRE, Beech Creek, July 7 (RLC), Scotia, June 11 (SWF); CLINTON, Tamarack, June 25 (SWF); CRAWFORD, Linesville, June 15 (RBP); MERCER, Pymatuning, June 5 (SWF); SULLIVAN, Lake Mokoma, June 17, 29 (GHB); WAYNE, Bear Swamp, July 24 (SWF).

*Chrysops geminata* Wied.: ADAMS, York Springs, June 28, July 6, 11, 23 (SWF); ALLEGHENY, June 21, Jeanette specimen without data; BEAVER, Racoon Cr. Park, June 30 (SWF); BEDFORD, Pavia, July 6; BRADFORD, Sand Run Mine, June 17 (SWF); BUTLER, June 28 (GEW); CENTRE, Beaver Dam, July 10 (SWF), Decker Valley, July 18 (VRH), Potters Mills, July 5 (VRH), State College, July 4 (GHB); CLINTON, Sugar Run, June 30 (RLC); CUMBERLAND, Carlisle Jc., July 9 (ED), Hunters Run, July 2 (ED); DAUPHIN, Dauphin, July 18 (ED), Enterline, July 3, Inglenook, July 18 (HBK), Penbrook, June 19 (HPBailey), Rockville, June 28 (ED), July 11, 22; ELK, Medix Run, July 6 (SWF); FAYETTE, Ohiopyle, July 22 (SWF); LUZERNE, Hazleton, no date; NORTHAMPTON, July 27 (ED), July 4-16; POTTER, Cherry Springs, July 31 (SWF), Morris, July 3 (SWF), Stony Fork, July 3 (SWF); WAYNE, Waymart, July 24 (SWF); WESTMORELAND, July 20.

*Chrysops geminata impuncta* Kr.: WESTMORELAND, Powder Mill, July 17 (GEW).

*Chrysops inda* O.S.: ALLEGHENY, Harmarville, May 22-31 (HK), Pittsburgh, June 8, 24; BLAIR, Bellwood, no data; BRADFORD, Beaver Dam, July 17 (SWF); BUCKS, Perkasie, June 18 (ED); CENTRE, Beaver Dam, June 12, 22 (SWF), Black Moshannon, June 8, 13, 27 (SWF), Potters Mills, June 8 (SWF), Scotia, June 10, 16 (SWF), July 11, 26 (GHB); CLEARFIELD, Shawville, May 1, 20, 25 (JB); CLINTON, Sugar Run, May 29 (RLC); CRAWFORD, Linesville, June 20 (SWF), June 18, 24 (RBP); CUMBERLAND, New Cumberland, May 29 (PRMyers), June 19 (HBK); DAUPHIN, Camp Hill, June 7 (ED), Harrisburg, June 26; DELAWARE, Broomall, July 1; ELK, Bendigo Park, July 7 (SWF); ERIE, North East, June 4; FOREST, Tionesta, June 25 (SWF); HUNTINGDON, Penn. Furnace, July 19 (SWF), Whipple Dam, June 27 (SWF); MONTGOMERY, Edge Hill, May 17 (ED); SOMERSET, Mt. Davis, June 10 (C); SULLIVAN, L. Mokoma, June 17, July 8 (GHB), Ricketts Glen, July 17 (SWF); TIOGA, Bradley Wales, July 3 (SWF), Morris, July 3 (SWF); UNION, Halfway Park, June 21 (SWF).

*Chrysops lateralis* Wied.: BRADFORD, Beaver Dam, July 17 (SWF), Sand Run Mine, July 17 (SWF); CAMERON, Emporium, July 20 (LLP); CENTRE, Bear Meadows, July 15 (SWF); LUZERNE, Wilkes-Barre, July 2 (ABC); MONROE, Cresco, June 7 (JNK), Locust Ridge, July 7 (Rehn), Pocono

Lake, July 10, 23; PIKE, Paupac, July 1 (WWMiddlekauff), July 9; SULLIVAN, Lake Mokoma, July 8 (GHB).

*Chrysops moecha* O.S.: CENTRE, Bear Meadows, June 29 (SWF), Penn Rsvlt. Dam, July 19 (SWF), State College, July 4 (GHB), The Rock, June 22, July 6, 12, 14 (SWF); CUMBERLAND, New Cumberland, June 4; DAUPHIN, Harrisburg, June 12 (HBK), June 4 (ABC), June 26, July 12, Hummelstown, June 16 (JNK), Inglenook, June 23 (HBK), Clarks Valley, June 4 (ABC); DELAWARE, Castle Rock, June 16, 30 (ED); HUNTINGDON, Charter Oak, June 26 (JNK); MERCER, Sharon, July 8 (HEOrtmann); PERRY, Marysville, June 30 (ED), Perdix June 2; YORK, Conewago, July 1.

*Chrysops montana* O.S.: BRADFORD, Beaver Dam, *July* 17 (SWF); CENTRE, Black Moshannon, June 3, 10, 14, 16, 19, 28, 29, 30, July 3, Aug. 14 (SWF), Scotia, June 22 (GHB), July 22 (SWF).

*Chrysops nigra* Macq.: ALLEGHENY, Gayasuta Run, June 2 (HK), Gibsonia, June 1 (GEW), Harmarville, June 24 (HK), Pittsburgh, June 1-7, 15, 24, Sharpsburg, June 12 (Sweadner); BEAVER, New Galilee, June 22, Racoon Cr. Pk., June 7 (CWS); BEDFORD, New Paris, June 19; BRADFORD, Sand Run Mine, July 17 (SWF); BUTLER, June 28 (GEW); CENTRE, Beaver Dam, June 6, 13 (SWF), Bear Meadows, July 7, 10 (SWF), Black Moshannon, June 13 (SWF), Fillmore, June 9, 19 (SWF), Penn Rsvlt. Dam, June 19 (SWF), Potters Mills, June 30 (SWF), State College, June 26 (GHB), The Rock, June 5, 17 (SWF); CLEARFIELD, Shawville, June 15, 21 (JB); CLINTON, Tamarack, June 29 (SWF); CRAWFORD, Conneaut Lake, June 5 (HK), Hartstown, July (HK), Linesville, June 11, 12, 14-16, 20, 24, 26, July 7 (RBP), Meadville, June 14 (LEAdams); CUMBERLAND, Carlisle, June 9, Enola, June 1; DAUPHIN, Clarks Valley, June 26 (ABC), Harrisburg, Wetzel Swamp, May 30, Hummelstown, July 4 (JNK), Manada Gap, June 16 (CSA), Progress, June 11 (HPBailey), Rockville, June 25; DELAWARE, Castle Rock, May 29, June 3; ELK, St .Mary's, June 27 (SWF); ERIE, Erie, June 21 (LEAdams); FAYETTE, Chalk Hill, June 7; FOREST, Kellettville, July 19, Cook's Forest, June 24 (VRH); HUNTINGDON, Greenwood Furnace, June 24 (SWF), Penn Furnace, June 9 (SWF), Stone Valley, June 24; INDIANA, No further data; JUNIATA, Reeds Gap, June 15 (SWF); LYCOMING, Trout Run, June 12 (LLP); MERCER, Pymatuning, June 5 (SWF); NORTHAMPTON, Hecton Mills, June 15 (HPBailey), Lehigh Gap, July 12; PHILADELPHIA, Olney, June 17 (ED), Philadelphia, June 4; PIKE, Promised Land, June 10 (HCWill); POTTER, Austin, June 15 (SWF); SULLIVAN, Lake Mokoma, June 17, 29 (GHB), Ricketts Glen, June 17 (SWF); TIOGA, Bradley Wales, July 3 (SWF); VENANGO, Drake Well State Pk., June 22 (RRB); WASHINGTON, Finleyville (HEngel), Washington, May 20; WESTMORELAND, Jeanette (Klages); YORK, Marsh Run, June 3 (ED).

*Chrysops sackeni* Hine.: CENTRE, Bear Meadows, July 2, 10, 25 (SWF-VRH), Beaver Dam, July 10, 13 (SWF), Black Moshannon, June 22, 29, July 6 (SWF), Whipple Dam, June 17, July 18 (SWF); CRAWFORD, Linesville, June 12, 13 (RBP); DAUPHIN, Harrisburg, July 8 (ED); ELK, Medix Run, July 6 (SWF); MERCER, Pymatuning, June 5 (SWF); SULLIVAN, Ricketts Glen, June 17 (SWF).

*Chrysops shermani* Hine.: BRADFORD, Beaver Dam, July 17 (SWF); CENTRE, Beaver Dam, June 22 (SWF), Black Moshannon, Aug. 2 (SWF), Tussyville Gap, July 11 (SWF), Scotia, June 11, July 22 (SWF); CLINTON, Tamarack, July 3 (SWF); ELK, Twin Lakes, July 7 (SWF), Bendigo Pk., July 7 (SWF); FOREST, Marienville, Aug. 8 (CWS); MCKEAN, Bradford, June 29, July 12 (LIP); POTTER, Cherry Springs, July 31 (SWF); SULLIVAN, Lake Mokoma, June 7 (SWF), June 17, July 8, 29 (GHB), Ricketts Glen, June 17 (SWF); TIOGA, Bradley Wales, July 3 (SWF), Morris July 3 (SWF).

*Chrysops striata* O.S.: One specimen in the Academy of Natural Science of Philadelphia labelled Pa.

*Chryspos univittata* Macq.: ADAMS, Floradale, June; ALLEGHENY, Gibsonia, June 26, 27, July 6, 19, Aug. 12 (GEW), North Park, June 7 (RBP), Pittsburgh; BEAVER, 5 miles south Shipping Port, June 27 (R-C), Racoon S. Pk., July 1 (C); BEDFORD, Pavia, June 2, 6, 7; BLAIR, Bellwood; CENTRE, Bear Meadows, July 15, 25 (SWF), Aug. 4 (VRH), Aug. 21 (JGS), Beaver Dam, June 20 (SWF), Decker Valley, July 15 (VRH), Potters Mills, July 5 (VRH), State College, June 15 (SWF), The Rock, June 30, July 6 (SWF), Scotia, June 20 (SWF), Whipple Dam, June 12 (SWF); CLEARFIELD, Curwensville, June 25, Shawville, June 15, 21, Aug. 20 (JB); CLINTON, Little Kettle Cr., July 31 (SWF), Sugar Run, July 6, 21 (RLC); CRAWFORD, Linesville, June 18-21, 27 (RBP); CUMBERLAND, Mt. Holly, June 22; DAUPHIN, Clarks Valley, June 28, Enterline, July 9 (JGS), July 3, 17, Highspire, May 30, Inglenook, June 4, 17 (ED), June 23, 26 (HBK), Linglestown, June 30 (GMG), Manada Gap, May 26 (ABC-CSA), Penbrook, June 19 (HDBailey); DELAWARE, Swarthmore, July 4; ELK, Bendigo Pk., July 7 (SWF); ERIE, Erie, June 21 (LEAdams), North East, June (GMG); FAYETTE, Ohiopyle, June 28 (SWF), Aug. 10, 11 (SWF); FOREST, Tionesta, June 25 (SWF); FRANKLIN, Caledonia, June 30, July 30 (SWF); HUNTINGDON, Stone Valley, June 25; INDIANA, Buena Vista, July 2 (RHMcCauley); LACKAWANNA, Spring Brook, June 28, July 8; LUZERNE, Hazleton, June 3; LYCOMING, Picture Rocks, July 18 (SWF), Trout Run, July 17 (SWF); MIFFLIN, Bear Gap, Aug. 7 (SWF); MONTGOMERY, Glenside, July 5; NORTHAMPTON, Lehigh Gap, July 14; PERRY, Green Valley, June 17 (ABC-HBK); PHILADELPHIA, Lindley, June 12 (ED), Torresdale, June 15; POTTER, Cherry Springs, July 31 (SWF); SNYDER, McClure, June 30 (RLC); SOMERSET, Shanksville, June 30 (RRB); TIOGA, Morris, July 3 (SWF), Stony Fork, July 3

(SWF); WESTMORELAND, July, Jeanette (Klages), Powder Mill, June 20 (C), July 11 (RC); YORK, York, June 6 (ED).

*Chrysops vittata* Wied.: ADAMS, York Springs, June 11 (SWF); ALLEGHENY, Allegheny, June 4, Jeanette (Klages), Pittsburgh, June 29, July 8, 10, 12, 27, Aug. 1 (HK); BLAIR, Bellwood, no further data; BRADFORD, Sand Run Mine, July 17 (SWF); BUCKS, Falsington, July (JAC); BUTLER, Portersville, June 28 (GEW); CENTRE, Bear Meadows, July 10, 14, 25, 26 (SWF), Aug. 4 (VRH), Aug. 21 (JGS), Black Moshannon, June 27, July 14, 15 (SWF), Fillmore July 4 (SWF), Scotia, June 22 (SWF), State College, July 6 (SWF), Tussyville Gap, July 11 (SWF), Whipple Dam, June 12, July 5 (SWF); CLEARFIELD, Shawville, Aug. 26 (JB); CLINTON, Sugar Run, July 6, 21 (RLC), Tamarack, Sept. 9 (SWF); CRAWFORD, Hartstown, July 4, 18 (GEW), Linesville, June 18, 22 (RBP); CUMBERLAND, Hunters Run, July 23 (ED), Mt. Holly, July 27; DAUPHIN, Enterline, July 3, Harrisburg, Aug. 20, Inglenook, July 4 (ED), July 15 (HBK), Linglestown, June 30 (GMG); DELAWARE, Castle Rock, July 25; ERIE, Presque Isle, July 7, 15 (LLP), Wintergreen Gorge, July 29 (GEW); FAYETTE, Ohiopyle, July 20, 22 (SWF); FOREST, Marienville, Aug. 9 (CWS); HUNTINGDON, Whipple Dam, July 18 (SWF); INDIANA, Indiana no further record; JEFFERSON, Brockway, Aug. 16 (RRB), Allens Mills, Aug. 8 (RRB); LEBANON, Cleona, Aug. 14 (CClagett); LEHIGH, Coopersburg, Aug. 6; LUZERNE, Hazleton; MIFFLIN, Bear Gap, Aug. 7 (SWF), Wagner Gap, Aug. 7 (SWF); NORTHAMPTON, Lehigh Gap, July 2, 4; PHILADELPHIA, Overbrook, July 19, Philadelphia, July 13; POTTER, Ole Bull, June 11 (SWF), Cherry Springs, July 31 (SWF); SNYDER, McClure, June 20 (RLC); SOMERSET, Shanksville, June 30 (RRB); SULLIVAN, Lake Mokoma, July 8 (GHB); SUSQUEHANNA, July 6; VENANGO, Drake Well Pk., June 22 (RRB); WAYNE, Promopton, July 24 (SWF), Waymart, July 24 (SWF); WESTMORELAND, Greensburg, June 26 (DHCross).

*Chrysops wiedemanni* Krb.: ADAMS, York Springs, July 11, 16, 17, 27, Aug. 9 (SWF); ALLEGHENY, Allegheny, June, July; BUTLER, Portersville, June 28 (GEW-CWS); CENTRE, Penn. Rsvlt. Dam, July 18 (SWF), Shingletown, July 2 (VRH), State College, June 22, July 28 (SWF), The Rock, July 12 (SWF), Whipple Dam, June 12 (SWF); CLEARFIELD, Shawville, Aug. 26 (JB); CLINTON, Sugar Run, July 22 (RLC); CRAWFORD, Hartstown, July 4, Aug. 1-7 (HK); CUMBERLAND, Carlisle Jc., July 1 (WRW); DAUPHIN, Harrisburg, June 26, July 6 (HBK), Aug. 10, Inglenook, July 4; ELK, Bendigo Pk., July 7 (SWF); ERIE, Presque Isle, June 8-13 (GEW); LACKAWANNA, Spring Brook, Aug. 13 (HTownes); LANCASTER, Lancaster, July 13 (BFCoon); LUZERNE, Hazleton; MONTGOMERY, Telford, June 20 (LStannard); NORTHAMPTON, Lehigh Gap, July 4, 5, 11, 12; PHILADELPHIA, Roxborough, July 6; POTTER, Cherry Springs, July 31 (SWF); SOMERSET, Shanksville, June 30 (RRB); VENANGO, Drake Well Pk., June 22 (RRB); WAYNE, Keene Lk., June 24 (SWF); WESTMORELAND, Jeanette.

*Chrysozona champlaini* Philip: DAUPHIN, Hummelstown, June 10 (JGS), (Type locality).

*Chrysozona rara* (Johnson): ADAMS, York Springs, June 24, 28 (SWF); DAUPHIN, Rutherboro, June 28 (JNK); DELAWARE, Folsom (Type locality); PERRY, June 24 (JGS).

*Atylotus bicolor* (Wied.): ADAMS, York Springs, July 11 (SWF); BEAVER, New Galilee, Oct. 10 (HK); CENTRE, Scotia, June 25 (SWF); DAUPHIN, Harrisburg, July 8 (WRW); ERIE, Presque Isle, Aug. 8 (GEW); PHILADELPHIA, Roxborough, July 6.

*Atylotus ohioensis* (Hine): DAUPHIN, Hummelstown, July 4 (JNK); ERIE, North East, July 22 (JNK); NORTHUMBERLAND, Lehigh Gap, July 3; WESTMORELAND, Jeanette (Klages).

*Atylotus pemeticus* (Johnson): MONROE, Pocono Lake, July 11.

*Atylotus thoracicus* (Hine): LYCOMING, North Mountain, June 8; MONROE, Pocono Lake, July 12; SULLIVAN, Sonestown, July 1 (RRauch).

*Tabanus* (*Hybomitra*) *affinis aurilimbus* Stone: BRADFORD, Columbia Cross Roads, July 4; CENTRE, Black Moshannon, July 5 (SWF); CRAWFORD, July 4 (HK).

*Tabanus* (*Hybomitra*) *cinctus* Fab.: CAMERON, Emporium, July 20 (LLP); CENTRE, Tussyville Gap, July 25 (VRH); CHESTER, Westchester, May (HLAdams); DAUPHIN, Clarks Valley, June 28 (ABC), Aug. 20 (FMTrimble), Rockville, June 19, 28, July 4, 9 (ABC); FOREST, Endeavor, July 30 (JNK); FRANKLIN, July 20 (ABC-TLG); LEBANON, Lotell, July 29; MONROE, Pocono Lake, June 22-30, July 9; NORTHAMPTON, Lehigh Gap, July 13; SCHUYLKILL, Tamaqua, July 26 (CWFenniger); WESTMORELAND, July.

*Tabanus* (*Hybomitra*) *difficilis* Wied. (= *carolinensis* of authors): ALLEGHENY, Coraopolis, June 23 (HK), Pittsburgh, Sharpsburg, May 30, June 13; BERKS, Wernersville, June 1; BRADFORD, Sand Run Mine, July 17 (SWF); CENTRE, Fillmore, June 19 (SWF); Black Moshannon, June 21 (SWF), The Rock, June 11, 12, 19 (SWF), Scotia, June 11 (SWF); CLARION, Clarion, June 20 (LEAdams); CLEARFIELD, Shawville, April 20, May 25, June 2, 21 (GEW); CLINTON, Sugar Run, May 29, June 14, 16 (RLC), Tamarack, June 25 (SWF); CRAWFORD, Meadville, June 14 (LEAdams); DAUPHIN, Clarks Valley, May 30, June (ABC), Inglenook, June 29, Rockville, June 18, Harrisburg, May 20 (LLP), Linglctown, June 18; DELAWARE, Castle Rock (ED); ELK, St. Mary's, June 14 (WWild); FAYETTE, Chalk Hill, June 7 (CWS); FOREST, Hickory Run, June 18 (SWF-GHB); Marienville, July 25 (KSwartz); HUNTINGDON, Charter Oak, June 26; INDIANA, June 17 (SWF); JEFFERSON, Brookville, Aug. 16 (LEAdams); LACKAWANNA, Spring Brook, May 25; LYCOMING, Trout Run, June 10 (LLP); PERRY, So. Fork Camp (HBK); PHILADELPHIA, June; SULLIVAN, Sonnestown, July 1 (RRauch); VENANGO, Pithole Cr., June 18 (SWF-GHB); WASHINGTON, Finleyville, May 22 (HEngel), June 2, 4, 5, 10, 11, 20; WESTMORELAND, Powder Mill, May 31 (RC), June 13.

*Tabanus* (*Hybomitra*) *epistates* O.S.: CLINTON, Sugar Run, July 12 (RLC); CRAWFORD, Conneaut Lake, July 5 (HK), Linesville, June 14, 30 (RBP); MERCER, Pymatuning, July 5 (SWF).

*Tabanus* (*Hybomitra*) *hinei* Johnson: DAUPHIN, Clarks Valley, July 8 (ABC).

*Tabanus* (*Hybomitra*) *illotus* O.S.: CRAWFORD, Linesville, June 11 (RBP).

*Tabanus* (*Hybomitra*) *lasiopthalmus* Macq.: ADAMS, York Springs, June 2 (SWF); ALLEGHENY, North Park, June 7 (RBP), Pittsburgh, June 15, 21 (HK); ARMSTRONG, Snow Hill, June 18 (HBK); BUTLER, Slippery Rock, June 21, Vasler Lake, June 14; CAMBRIA, Portage, May 15 (JNK); CENTRE, Beaver Dam, June 13 (SWF), Penn. Rsvlt. Dam, May 27 (LStannard), Pine Grove Mills, June 8 (SWF), Scotia, June 11 (SWF), State College, June 15 (SWF); CLINTON, Sugar Run, May 29, June 7, 14, 16 (RLC); CRAWFORD, Linesville, June 14, 15, 19, 24, July (RBP), Sugar Lake, June 10 (BEW), July 19 (SWF); CUMBERLAND, New Cumberland, June 4; DAUPHIN, Clarks Valley, May 30, June 14 (ABC), Harrisburg, June 12 (HBK), June 21 (TLG), May 30, June 6, Hummelstown, June 7 (JGS), May 26 (JNK), Manada Gap, June 6 (CSA); DELAWARE, Castle Rock, June 16 (ED), Wawa, May 25 (ED); ERIE, Erie, July 15 (SWF); FOREST, Marienville, July 26 (Swartz), Tionesta, July 27 (LEAdams); JEFFERSON, Brookville, Aug. 16 (LEAdams); LACKAWANNA, Scranton, June 7 (WMEddy); LAWRENCE, Slippery Rock Cr., June 25 (JB); LEBANON, Mt. Gretna, June 10 (BFCoon); LUZERNE, Hazleton, June 12 (JGS); MERCER, Pymatuning, June 5 (SWF); MONTGOMERY, Glendale, June 4 (ED), Norristown, June 27; SULLIVAN, Lake Mokoma, June 7 (SWF); WASHINGTON, Finleyville, June 14, McConnells Mill, May 20; WAYNE, Waymart, July 24 (SWF); WESTMORELAND, Jeanette.

*Tabanus* (*Hybomitra*) *microcephalus* O.S.: CENTRE, Bear Meadows, July 25 (SWF), Beaver Dam, July 2 (FAGlover), Livionia, July 10 (VRH), Penn. Rsvlt. Dam, Aug. 8 (SWF), Shingletown, July 2 (VRH), State College, June 8 (SWF); CLINTON, Little Kettle Cr., June 31 (SWF), Tamarack, July 31 (SWF); COLUMBIA, Aug. 8 (HK); DAUPHIN, Clarks Valley, July 16, Aug. 26 (ABC); MIFFLIN, Wagner's Gap, Aug. 7 (SWF); PIKE, Milford, July 29 (RRauch), Aug. 31 (HBradford); POTTER, Ole Bull, July 31 (SWF); TIOGA, Stony Fork, July 3 (SWF).

*Tabanus* (*Hybomitra*) *minisculus* Hine.: CENTRE, Bear Meadows, July 10 (SWF).

*Tabanus* (*Hybomitra*) *trepidus* McD.: CENTRE, Bear Meadows, June 10 (SWF), July 2, 17, 25 (SWF), July 18 (GHB), July 19 (RLC).

*Tabanus* (*Hybomitra*) *trispilus* Wied.: CENTRE, Bear Meadows, July 5, 25 (SWF); CLINTON, Sugar Run, July 5 (RLC); DAUPHIN, Clarks Valley, June 25, July 17 (ABC), Manada Gap, July 3 (HBK); ERIE, Erie, July 29 (HK); HUNTINGDON, Charter Oak, June 20 (JNK), July 11 (HBK-JNK); LEBANON, Mt. Gretna, June 16; PERRY, Weaver, June 24; TIOGA,

Wellsboro, July 3 (SWF), Bradley Wales, July 3 (SWF); UNION, Weikert July 3 (GHB); WESTMORELAND, July.

*Tabanus* (*Hybomitra*) *typhus* Whitney: BRADFORD, Sand Run Mine, July 17 (SWF); CENTRE, Penn. Rsvlt. Dam, July 18 (SWF), Woodward, July 3 (GHB); CUMBERLAND, Hunters Run (ABC); DAUPHIN, Clarks Valley, July 17 (ABC); ELK, Bendigo Park, July 7 (SWF), Medix, July 6 (SWF); LYCOMING, English Center, July 31 (SWF); SULLIVAN, Hills Grove, July 17 (Rauch), Lake Mokoma, June 17 (SWF-GHB), Ricketts Glen, June 17 (SWF); TIOGA, Morris, July 3 (SWF), Stony Fork, July 3 (SWF), Wellsboro, July 3 (SWF), July 12 (SGesell); WAYNE, Waymart, July 24 (SWF).

*Tabanus* (*Hybomitra*) *zonalis* Kirby: CENTRE, Bear Meadows, June 10 (SWF); MONROE, Cresco, June 9 (HBK); PIKE, Notch, June 22.

*Tabanus* (*Tabanus*) *atratus* Fab.: ALLEGHENY, Oak Station, Aug. 3, Ingram, July 24 (McI), Pittsburgh, June 4, 7, 20, Aug. 12, 24; CENTRE, Decker Valley, July 19 (VRH), The Rock, June 25 (SWF); CLINTON, Sugar Run, June 30 (RLC); CUMBERLAND, Bowmansdale, Aug. 16; DAUPHIN, Harrisburg, Aug. 11 (ED), June 21 (CSA), Hummelstown, Aug. 9 (JNK), Inglenook, June 4, Manada Gap, June 26 (CSA), Rockville, July 23, Aug. 18 (ED); LANCASTER, Lancaster, June 24 (HCHallock), July 19 (BFCoon); MONTGOMERY, Green Lane, Aug. 12; WASHINGTON, Finleyville, June 5, 8, 15, 20, Aug. 10; WESTMORELAND, Jeanette, July 11, Rector, July 4.

*Tabanus* (*Tabanus*) *calens* Linn. (= *giganteus* Degeer): ALLEGHENY, Zorobsky; BUCKS, Falsington, July (JAC); CLINTON, Sugar Run, Aug. 3 (RLC); DAUPHIN, Harrisburg, Aug. 2, Linglestown, Aug. 12, Aug. 20, Sept. 5 (ABC); FULTON, McConnellsburg, Aug. 20 (RRauch); LANCASTER, Mt. Gretna, Aug. 25 (BFCoon); LAWRENCE, New Wilmington, Aug.; PHILADELPHIA, Philadelphia.

*Tabanus* (*Tabanus*) *catenatus* Walk. (= *orion* O.S.): CENTRE, State College, June 17, Aug. 1, 2, 7 (SWF); DAUPHIN, Clarks Valley, July 26 (ABC); FRANKLIN, Caledonia, Oct. 12 (Brimley); MIFFLIN, Aitkin, Sieglerville, Aug. 7 (SWF); MONROE, Long Pond, July 27 (HBK); PIKE, Milford, July.

*Tabanus* (*Tabanus*) *fairchildi* Stone (= *vivax* of authors): ALLEGHENY, Gayasuta Run, July 6 (HK); DAUPHIN, Harrisburg, June 28, Inglenook, June 29 (ABC-HBK); FOREST, Endeavor, July 21 (HBK); NORTHAMPTON, Lehigh Gap, July 2, 14; PERRY, Perdix, June 11; PIKE, Milford, June 29 (RRauch).

*Tabanus* (*Tabanus*) *fulvulus* Wied.: CENTRE, Tussy Mt., July 19 (SWF); MIFFLIN, Wagner Gap, Aug. 7 (SWF).

*Tabanus* (*Tabanus*) *lineola* Fab.: CLINTON, Sugar Run, June 16, July 12, 21, 22 (RLC); CRAWFORD, Linesville, June 19 (RBP); CUMBERLAND, Hunters Run, June 19 (ED); MIFFLIN, Wagner Gap, Aug. 7 (SWF); PHILADELPHIA, Philadelphia, July 14; TIOGA, Wellsboro, July 3 (SWF).

*Tabanus* (*Tabanus*) *lineola scutellaris* Walker: ADAMS, Arendtsville, June 9, July 5, 12, 15, 19, 27 (SWF), York Springs, June 3, 24, 25, July 11, 27 (SWF); ALLEGHENY, Powers Run, July 31, Pittsburgh, June 2, 30, July 7, July 19 (HK); BRADFORD, West Franklin, July 17 (SWF); CENTRE, Boalsburg, June 23 (SWF), Tussyville Gap, July 11 (SWF); CLINTON, Sugar Run, May 29, June 7, 14, 16, July 16, 21 (RLC), Tamarack, July 31 (SWF); DAUPHIN, Colonial Pk., July 4 (GMG), Inglenook, June 28 (ABC-JNK); ERIE, Erie, Aug. 7 (LEAdams); FAYETTE, Dunbar, June 24; HUNTINGDON, Charter Oak, July 11 (JNK), Cove, July 4 (ED); JEFFERSON, Brookville, Auf. 16 (LEAdams), Allens Mills, Aug. 8 (RRB); PHILADELPHIA, Philadelphia; SULLIVAN, Wheelerville, June 24; TIOGA, Wellsboro, July 31 (SWF); WAYNE, Bear Swamp, July 24 (SWF), Waymart, July 24 (SWF); WESTMORELAND, Jeanette, July (HGKlages).

*Tabanus* (*Tabanus*) *longus* O.S.: ALLEGHENY, Gibsonia, July 28 (GEW); CENTRE, State College, July 20 (SWF); DAUPHIN, Rush Township, July 2 (ABC), Powl Valley, Aug. 17; LEBANON, Lotell.

*Tabanus* (*Tabanus*) *melanocerus* Wied.: PHILADELPHIA, Philadelphia.

*Tabanus* (*Tabanus*) *molestus* Say: DAUPHIN, Clarks Valley, Aug. 20 (FMTrimble).

*Tabanus* (*Tabanus*) *nigrescens* P. de B.: ADAMS, Arendtsville, July 12 (SWF), York Springs, July 13, 23, 27 (SWF); CENTRE, Bear Meadows, July 20 (SWF); CLINTON, Sugar Run, July 21, 22 (RLC); DAUPHIN, Clarks Valley, July 25 (ABC), Enterline, July 17 (ED), Inglenook, July 18 (HBK), Manada Gap, July 3 (JNK), Rockville, July 23; FAYETTE, Dunbar; LAWRENCE, Slippery Rock; WASHINGTON, Finleyville (HEngel); WESTMORELAND, Rector, June 22; ALLEGHENY, Mts., July, (Atkinson-Link).

*Tabanus* (*Tabanus*) *nigripes* Wied. (= *coffeatus* Macq.): BRADFORD, Sand Run Mine, July 7 (SWF); DAUPHIN, Manada Gap, Aug. 14 (CSA); NORTHAMPTON, Lehigh Gap, July 7; PHILADELPHIA, Philadelphia.

*Tabanus* (*Tabanus*) *nivosus* O.S.: BRADFORD, Beaver Dam, July 17 (SWF); CRAWFORD, Linesville (RBP); ELK, Bendigo Park, July 7 (SWF).

*Tabanus* (*Tabanus*) *pumilis* Macq.: ADAMS, York Springs, June 25, 28, 30, July 3 (SWF); BERKS, Frystown, Aug. 2; BUCKS, Perkasi, June 18 (ED); CENTRE, Potters Run, July 7 (VRH); CHESTER, Kennett Square, June 20 (CAThomas); CLINTON, Sugar Run, June 7, 14, 16, July 5, 12, 16, 18, 20-22 (RLC), Tamarack, June 22 (SWF); CRAWFORD, Hartstown, July 29 (HK), Linesville, June 19, 20, 25, July 4, 5 (RBP); CUMBERLAND, Hunters Run, June 19 (ED), June 2, July 23, 28; DAUPHIN, Clarks Valley, June 28, July 12 (ABC), Harrisburg, June 12 (HBK), Hummelstown, June 6 (JNK), Manada Gap, July 3, Aug. 5 (JNK), June 6 (CSA), Rockville, July 12 (ED); PIKE, Paupac, July 1 (WMiddlekauff); VENANGO, Drake Well Pk., June 22 (RRB); WESTMORELAND, Powder Mill, June 18 (R).

*Tabanus* (*Tabanus*) *quinquevittatus* Wied. (= *costalis* Wied., *vicarius* Walk.): ADAMS, Gettysburg, June 14, York Springs, July 3, Aug. 11 (SWF); ALLEGHENY, Gibsonia, July 29 (GEW), Oak Station, June 29; ARMSTRONG, Lane August, (JSteinhauer); BEAVER, New Galilee, July 3; BLAIR, August 3; BRADFORD, West Franklin, July 17 (SWF); BUCKS, Doylestown, Aug. 29 (WHYackley); CENTRE, Boalsburg, June 22, July 19 (SWF), Penn. Rsvlt. Dam, July 19 (SWF), State College, June 24; CHESTER, Westchester; CLINTON, Sugar Run, June 16, 30, July 5, 12, 16, 18, 20-22 (RLC), Tamarack, June 31 (SWF); CRAWFORD, Hartstown, July (HK), Linesville, Aug. 6 (RBP), Pymatuning, Aug. 6, 8 (GEW); DAUPHIN, Linglestown, June 8; ERIE, Erie, Aug. 7 (LEAdams), Lk. Leboeuf, Aug. 5 (HK), Lk. Pleasant, Aug. 21 (HK); FOREST, Tionesta, July 20 (LEAdams); GREENE, Waynesburg, Aug. 3; HUNTINGDON, Penn. Furnace, July 9 (SWF); JEFFERSON, Allens Mills, Aug. 8 (RRB); LANCASTER, Lancaster, June 27, July 1, 11, Aug. 3 (BFCoon); McKEAN, Bradford, July 18 (LEAdams); NORTHAMPTON, Lehigh Gap, July 13, 15, 20; PHILADELPHIA, Angora, Aug. 18, Fairmount, July 14 (FHaimbach); TIOGA, Wellsboro, July 3 (SWF), July 12 (SGesell); WAYNE, Bear Swamp, July 24 (SWF), Waymart, July 24 (SWF); WESTMORELAND, July; YORK, Hanover, July 25 (NDBlackburn).

*Tabanus* (*Tabanus*) *recedens* Walker: ALLEGHENY, Allegheny (Klages); HUNTINGDON, Charter Oak, no date (JNK); PHILADELPHIA, Philadelphia.

*Tabanus* (*Tabanus*) *reinwardtii* Wied.: ADAMS, York Springs, July 13, (SWF); ALLEGHENY, Oak Station, July 31, Pittsburgh, June 23 (HK); BERKS, Aug. 23 (AThompson); BRADFORD, W. Franklin, July 17 (SWF); CENTRE, Pine Grove Mills, July 22 (EGMusser); CLINTON, Sugar Run, July 18, 21 (RLC); CUMBERLAND, Hunters Run, July 23 (ED), Williams Grove, July 27 (ED); DAUPHIN, Clarks Valley, July 10, 17 (ABC), Harrisburg, July (ABC), Inglenook, July 27 (ED), Progress, June 21; GREENE, Waynesburg, July 29; LANCASTER, Lancaster, Aug. 8 (WHYackley); MIFFLIN, Bear Gap, Aug. 7 (SWF); PERRY, New Bloomfield, July 18 (JNK); TIOGA, Wellesboro, July 3 (SWF); WARREN, Warren, Aug. 6; WASHINGTON, Finleyville (Engel); WESTMORELAND, Jeanette, Allegheny Mts., July (Atkinson & Link).

*Tabanus* (*Tabanus*) *sackeni* Fairchild: ALLEGHENY, Aspinwall, July 5, Cheswick, Aug. 7, Dorseyville, Aug. 25 (GEW), Gayasuta Run, Aug. 16 (HK), Gibsonia, Aug. 23-27 (GEW), Sept. 6 (JKDoutt), Pittsburgh, July 7, 11, 12, Aug. 21; BEAVER, August 29 (HK); CENTRE, Boalsburg, June 28 (SWF), State College, July 18, Aug. 1 (SWF), The Rock, Aug. 12 (SWF); CLINTON, Sugar Run, June 20, 22 (RLC); FAYETTE, Ohiopyle, Aug. 9; FRANKLIN, Caledonia, July 30 (SWF); GREEN, 3 mi. south Pine Bank, July 27 (CSudrick); HUNTINGDON, Camp Baree, July 7, Aug. 1, 5 (JEHawkins); MIFFLIN, Sieglerville Aitkin, Aug. 7 (SWF), Wagner Gap, Aug. 7 (SWF); PHILADELPHIA, Philadelphia, July 12;

SULLIVAN, Aug. 31 (RRauch); WASHINGTON, Finleyville, Aug. 11; WESTMORELAND, Powder Mill, Aug. 3 (RC), Aug. 10.

*Tabanus* (*Tabanus*) *sagax* O.S.: CLINTON, Sugar Run, July 16, 20, 22 (RLC); CUMBERLAND, Carlisle Jc., June 27 (JNK); NORTHAMPTON, July 10, 15.

*Tabanus* (*Tabanus*) *sparus* Whitney: DAUPHIN, Linglestown, July 23, Rockville, July 5; MONTGOMERY, Glenside, June 13; NORTHAMPTON, July 7, 9, 10, 16, 23; WESTMORELAND, July.

*Tabanus* (*Tabanus*) *sparus milleri* Whitney: ADAMS, York Springs, June 25, 28, 30, July 3, 6, 11, 12, 23, 27, 31 (SWF); BRADFORD, Beaver Dam, July 17 (SWF), Sand Run Mine, July 17 (SWF); CENTRE, Coyler, Aug. 3 (SWF), Poe Paddy, Aug. 21 (SWF), Potters Mills, July 8 (SWF), Shingletown, July 16 (SWF), Tussyville, July 11 (SWF), The Rock, June 27 (SWF); CLINTON, Sugar Run, June 30, July 5, 6, 20 (RLC); DAUPHIN, Linglestown, June 20 (GMG), Manada Gap, June 26, July 4 (CSA); HUNTINGDON, Whipple Dam, July 22; MIFFLIN, Wagner Gap, Aug. 7 (SWF); WESTMORELAND, Powder Mill, July 20 (RC).

*Tabanus* (*Tabanus*) *stygius* Say: CRAWFORD, Hartstown, Aug. 4 (HK); CUMBERLAND, Mechanicsburg, Aug. 4; DAUPHIN, Harrisburg, Rockville, June 18 (ABC); DELAWARE, Essington, July 7 (ED); JUNIATA, McCullocks Mills, June 27; MONTOUR, Danville, June 22; PHILADELPHIA, Philadelphia, June 30 (JSloan, June 26 (ED), July 7, 10, 13, Aug. 1.

*Tabanus* (*Tabanus*) *sublongus* Stone: DAUPHIN, Hummelstown, Sept. 2 (ED), Paratype.

*Tabanus* (*Tabanus*) *subniger* Coq.: ALLEGHENY, Gayasuta Run, June 2 (HK), Pittsburgh, June 2 (HK); HUNTINGDON, Charter Oak, June 20 (JNK); WESTMORELAND, Jeanette, July 11 (HGKlages).

*Tabanus* (*Tabanus*) *sulcifrons* Macq.: ADAMS, Gettysburg, July 17, York Springs, July 12, 13, 15, 17, 19, 21, 23, 27, 29, 30, Aug. 2, 9 (SWF); ALLEGHENY, Pittsburgh, July 12; BERKS, Frystown, Aug. 2; BRADFORD, Sand Run Mine, July 17 (SWF), Towanda, July 17 (SWF); CENTRE, Pine Grove Mills, July 22 (FAGlover), Shingletown, July 16, Tussy Mt., July 20 (SWF), Poe Paddy, Sept. 22 (SWF); CLINTON, Sugar Run, July 12, 16, 18, 20-22 (RLC); CRAWFORD, Linesville, Aug. 11 (RBP), Pymatuning, July 27; CUMBERLAND, Mt. Holly Springs, July 25; DAUPHIN, Clarks Valley, July 22 (RMBaker), Harrisburg, July 13 (CSA), Hummelstown, June 10, July 12 (JNK), Linglestown, Aug. 16, Manada Gap, June 25 (CSA), Rockville, July 25, Powl Valley, Aug. 17; DELAWARE, Broomal, July 24; ERIE, Erie, Aug. 7 (LEAdams), Presque Isle, Aug. 5 (HK); FOREST, Tionesta, July; FRANKLIN, Caledonia, Aug. 1, Blue Ridge Summit, Aug. 8, Mt. Alto, June 24, 28 (RKaufman); GREENE, Waynesburg, July 29; JEFFERSON, Brookville, Aug. 16 (LEAdams); JUNIATA, Coclamus, July 10 (TLG); LANCASTER, Columbia, July 24 (WHYackley); MERCER, Sharon, Aug. 18 (KSwartz); MIFFLIN, Bear Gap, Aug. 7 (SWF), Wagner Gap, Aug. 7 (SWF); NORTHAMPTON, Lehigh Gap, Aug. 21; PHILADELPHIA, Philadelphia, July

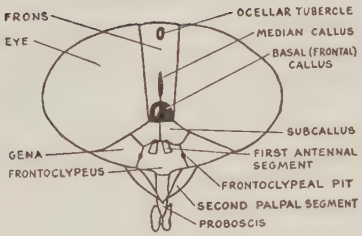
15; SULLIVAN, La Porte, Aug. 7 (RMBaker); TIOGA, Wellsboro, July 12 (SGesell); WASHINGTON, Cannonsburg, July 23 (CWS), Finleyville (HEngel); WESTMORELAND, Powder Mill, July 18 (ACLloyd); YORK, Conewango, Aug. 7; Allegheny Mts., July (Atkinson & Link).

*Tabanus* (*Tabanus*) *superjumentarius* Whitney: ALLEGHENY, Allegheny, May 5, Aspinwall, July 9, Pittsburgh, Aug. 15 (HK); CLINTON, Sugar Run, July 5, 16 (RCL); DAUPHIN, Clarks Valley, July 22 (RBaker); HUNTINGDON, Charter Oak, June 20 (JNK); MIFFLIN, Sieglersville (Aitkin), Aug. 7 (SWF); PHILADELPHIA, Fairmount Pk., June 25 (ED), July 12; TIOGA, Bradley Wales, July 3 (SWF); WESTMORELAND, Powder Mill, July 20 (RC).

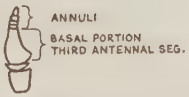
*Tabanus* (*Tabanus*) *trimaculatus* P. deB.: ADAMS, Biglerville, July 27 (TLG); ALLEGHENY, Aspinwall, July 4, Allegheny, June 22, Oak Station, June 3 (FMarloff); BUCKS, Falsington, July (JAC); CRAWFORD, Linesville, June 12 (RBP); CUMBERLAND, Carlisle Jc., June 28 (ED); DAUPHIN, Harrisburg, June 16 (HBK), July 15 (PTBarnes), June 22, July 1, Inglenook, July 4 (ED), Linglestown, June 26; HUNTINGDON, Charter Oak, June 20 (JNK), July 9 (ABC-HBK); MIFFLIN, Sieglersville (Aitkin), Aug. 7 (SWF); PHILADELPHIA, Philadelphia; WESTMORELAND, July.

## KEY TO THE GENERA OF PENNSYLVANIA TABANIDAE

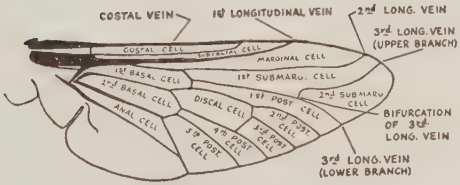
1. Hind tibiae with 2 apical spurs ..... **2**
   Hind tibiae without apical spurs ..... **4**
2. Flagellum of antenna with 5 distinct annuli; smaller species (7-9 mm.) with pictured wings ..... *Chrysops* Meigen
   Flagellum of antenna with 8 distinct annuli; larger species (12 mm.), often with clear wings ..... 3
3. Eyes of female with upper inner angles acute; frons broader than width of eye; wings with a dark pattern ..... *Goniops* Aldrich
   Eyes of female normal; frons narrower than width of eye; wings clear *Stonemyia* Brennan
4. First antennal segment longer than thick; frons of female widened below, broader than high; wings dark gray with white maculations *Chrysozona* Meigen
   First antennal segment usually scarcely longer than thick; frons of female higher than broad; wing pattern not as above or clear .... 5
5. Basal callus absent or vestigial; eyes pilose; no ocellar tubercle; eyes of male yellow-brown in dried specimens ..... *Atylotus* O.S.
   Basal callus well developed, nearly as wide as frons; at least lower eye facets of male blackish in dried specimens ..... *Tabanus* Linn.



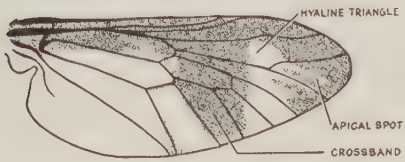

ANTERIOR VIEW OF HEAD OF *Tabanus illotus*.




ANTENNA OF *Tabanus illotus*.




WING OF *Tabanus illotus* (Markings not shown).




WING OF *Chrysops pikei*.

Text-figure 2.—Wing and head structures of Tabanidae. (After Pechuman).

## Key to the Species of Pennsylvania *Stonemyia*

1. Yellowish species including antennae and legs .... *isabellinus* (Wied.)
   Antennae at least partly dark; legs reddish to black ..... 2
2. Legs reddish brown; posterior margins of abdominal segments with grayish hairs ..... *rasa* (Lw.)
   Legs black; posterior margins of segments with yellow hair *tranquilla* (O.S.)

## Key to the Species of Pennsylvania *Atylotus*

1. Pleural hairs bright yellow; basal portion of third antennal segment about as broad as long ..... *bicolor* (Wied.)
   Pleural hairs gray; basal portion of third antennal segment variable, slender to broad ..... 2
2. Hair of abdomen white; basal portion of third antennal segment stout with dorsal angle usually near middle of length; frons of female moderate in width ..... *ohioensis* (Hine)
   Hair of abdomen yellow; basal portion of third antennal segment with dorsal angle basad of middle, shape variable, often somewhat slender; frons of female rather narrow ..... 3
3. Abundant black hair on palpi and prescutal lobe; abdomen in female dark brown narrowly yellowish on sides of first two tergites; hair of venter often white on first two segments; genae yellowish at least on upper portions ..... *pemeticus* (Johns.)
   Only scattered black hairs on palpi and prescutal lobe; abdomen in female usually fuscous in center, broadly yellowish on sides; hair on venter mostly yellow; genae gray with gray hairs *thoracicus* (Hine)

## Key to the Species of Pennsylvania *Chrysozona*

1. First antennal segment distinctly swollen, without dorsal notch; pale rings of tibiae narrow; pale apical wing band reaches posterior margin of wing; length 7 to 8 mm. ..... rara (Johns.)
   First antennal segment barely swollen, with a strong dorsal notch near apex; pale rings of tibiae broad; pale apical wing band not reaching posterior margin of wing; length 9 mm. ..... *champlaini* Philip

## Key to the Species of Pennsylvania *Chrysops*

### I. Females

1. Apex of wing beyond the crossband clear; black species ..... 2
   Apex of wing beyond the crossband infuscated so that an apical spot is present; yellow and black or gray and black species ..... 5
2. Second basal cell clear; frontoclypeus without a median pollinose stripe ..... *nigra* Macq.
   Second basal cell at least half infuscated; frontoclypeus with a median pollinose stripe ..... 3
3. Abdomen with a pale area laterally on first two segments *cuclux* Whith.
   Abdomen entirely dark, sometimes an indefinite pattern of grayish pollinose areas ..... 4
4. Pleura with yellow to orange-red pile; fifth posterior cell infuscated at base ..... *celer* O.S.
   Pleura with gray to yellow pile; fifth posterior cell with a clear area at base ..... *carbonaria* Wlk.
5. Frontoclypeus black with a median pollinose stripe ..... *frigida* O.S.
   Frontoclypeus shining yellow at least in center; no median pollinose stripe ..... 6
6. Crossband and apical spot broken by dilute areas along veins; abdomen striate ..... *shermani* Hine
   Dark markings of wing not broken by dilute areas ..... 7
7. First basal cell completely infuscated, rarely with a subhyaline spot at apex ..... 8
   First basal cell always at least half clear; sometimes almost entirely so ..... 15
8. Hyaline triangle small but clear and distinct, restricted to apices of second and third posterior cells ..... *moecha* O.S.
   Hyaline triangle extending toward costal margin beyond second posterior cell ..... 9
9. Predominantly dark brown species with traces of pale longitudinal lines on abdomen; hyaline triangle narrow and crescent shaped, reaching the second longitudinal vein; apical spot extensive, usually extending into the first posterior cell ..... *dacne* Philip
   Abdomen conspicuously marked in yellow and black ..... 10
10. Apex of hyaline triangle reaches second longitudinal vein *beameri* Brennan
    Apex of hyaline triangle does not reach second longitudinal vein .. 11
11. Abdomen with four more or less complete dark longitudinal stripes 12
    Abdomen not striped or with less than four stripes ..... 14
12. Most of fifth posterior cell infuscated; scutellum yellow *vittata* Wied.
    Fifth posterior cell almost entirely clear; scutellum dark, with or without paler apex ..... 13

13. Apical spot nearly fills second submarginal cell; two central stripes of abdomen rarely joined on second segment; frontal callus yellow *aberrans* Philip

Apical spot only about half fills second submarginal cell; two central abdominal stripes usually join on second segment; frontal callus usually black, sometimes brownish, rarely yellowish .... *striata* O.S.

14. Apical spot fills out most of second submarginal cell and extends into first and sometimes second posterior cell, usually connecting with crossband by an infuscated streak in the first posterior cell; abdomen with two stripes which are sometimes reduced to faint lines or enlarged to cover much of abdomen on each side of a yellow central stripe; scutellum usually with considerable yellow . *univittata* Macq.

Apical spot fills only about half of second submarginal cell and does not extend further; abdomen not striped; scutellum dark *inda* O.S.

15(7). Apical spot narrow, including at most only extreme apex of second submarginal cell ..... 16

Apical spot broad, entering second submarginal cell over at least one third of upper branch of third longitudinal vein ..... 18

16. Apical spot just beyond where it leaves the crossband slightly wider than marginal cell; frontal callus almost as high as wide, often yellow bordered with black or brown, occasionally black *sackeni* Hine

Apical spot at base narrower or just as wide as marginal cell; frontal callus black and usually considerably wider than high ..... 17

17. Apical spot very narrow and more dilute than crossband; front little convergent at vertex; pale markings of abdomen usually grayish or dull yellow; on the second abdominal segment are black triangles, one on each side of the median dark marking, and they may or may not be connected with the latter by a dark band along the posterior margin of the segment ..... *aestuans* Wulp

Apical spot varies from one half to full width of marginal cell and is same density as crossband; front some what convergent at vertex; pale markings of abdomen yellow which sometimes is quite bright; dark median marking of second abdominal segment may have projections along posterior margin of segment but they do not form lateral triangles ..... *callida* O.S.

18. Blackish species with a mid-dorsal yellow (rarely grayish) abdominal stripe and sometimes with shorter stripes on each side *wiedemanni* Krb.

Abdomen with a different pattern and showing more yellow ..... 19

19. Hyaline triangle distinctly crosses second longitudinal vein, nearly separating apical spot from crossband ..... 20

Hyaline triangle at most reaches second longitudinal vein ..... 22

20. Apical spot occupies only about half of second submarginal cell; crossband usually does not reach hind margin of wing ... *lateralis* Wied.
Apical spot occupies almost all of second submarginal cell; crossband reaches hind margin of wing ..... 21
21. Second abdominal segment with a black spot or two black spots narrowly divided ..... *geminata* Wied.
Second abdominal spot completely yellow ... *geminata impuncta* Krb.
22. Median figure of second abdominal segment an inverted "V"; remainder of abdominal pattern in form of four rows of spots *montana* O.S.
Median figure an inverted "V"; remainder of abdominal segments black with narrow yellow posterior margins and small median triangles ..... *dimmocki* Hine

## Key to the Species of Pennsylvania *Chrysops*

### II. Males

1. Apex of wing beyond the crossband clear, sometimes a vague cloud present in this area ..... 2
Apex of wing beyond the crossband infuscated so that an apical spot is present ..... 5
2. Frontoclypeus yellow with a black spot on each side; no pollinose midfacial stripe ..... *nigra* Macq.
Frontoclypeus black with a pollinose midfacial stripe ..... 3
3. First two abdominal segments with small pale spots laterally *cuclux* Whitn.
Abdomen completely dark ..... 4
4. Fifth posterior cell with a clear area at base ..... *carbonaria* Wlk.
Fifth posterior cell infuscated at base ..... *celer* O.S.
5. Frontoclypeus with a midfacial pollinose stripe which begins below antennae and runs at least half way to oral margin; integument of frontoclypeus usually entirely black ..... *frigida* O.S.
Frontoclypeus without a midfacial pollinose stripe; integument of face at least partly yellow ..... 6
6. Abdomen black with no yellow markings; hind femora black *moecha* O.S.
Abdomen with pale markings; hind femora variable ..... 7
7. Crossband and apical spot broken by dilute areas along veins *shermani* Hine
Crossband and apical spot not broken by dilute areas ..... 8
8. Black species; abdomen with a yellowish median longitudinal stripe, occasionally with a similar abbreviated stripe on each side; hyaline triangle crosses second longitudinal vein; apical spot rarely occupies more than half of second submarginal cell, often less *wiedemanni* Krb.
Not with this combination of characters ..... 9

9. Apical spot very little broader at its apex than at its origin, crossing upper branch of third longitudinal vein at its apex and occupying very little of the second submarginal cell ..... 10
   Apical spot considerably broadened towards its apex, crossing at least half of upper branch of third longitudinal vein ..... 12
10. Hyaline triangle not reaching second longitudinal vein .. *sackeni* Hine
    Hyaline triangle reaching or crossing second longitudinal vein .... 11
11. Second abdominal segment with sublateral black triangles which join the median figure along the posterior border of the segment; fourth posterior cell usually hyaline at apex and fifth posterior cell with considerable infuscation especially basally; pale markings grayish yellow; apical spot very narrow ..... *aestuans* Wulp
    Second abdominal segment without sublateral black triangles; fourth posterior cell usually infuscated and fifth posterior cell often mostly hyaline; pale markings yellow ..... *callida* O.S.
12. Abdomen bright yellow and black; large black figure of second abdominal segment broadly joined to black figure of first segment; median yellow triangles do not reach the anterior border of the segments; apical spot occupying one half to two thirds of second submarginal cell ..... 13
    Not with above combination of characters ..... 14
13. Abdomen with a sublateral row of black spots; median yellow triangles moderate in size; hyaline triangle extending beyond bifurcation of third longitudinal vein, sometimes reaching second longitudinal vein ..... *montana* O.S.
    Abdomen without a sublateral row of black spots; median triangles very small, sometimes obsolete; hyaline triangle ends at bifurcation of third longitudinal vein ..... *inda* O.S.
14. Apical spot filling about half or less of second submarginal cell .... 15
    Apical spot filling all or nearly all of second submarginal cell, sometimes extending into first posterior cell ..... 16
15. Frontoclypeus with a black spot on each side; hyaline triangle crosses second longitudinal vein ..... *lateralis* Wied.
    Frontoclypeus entirely yellow; hyaline triangle does not cross second longitudinal vein ..... *dimmocki* Hine
16. Hyaline triangle crosses second longitudinal vein; yellow species with black spots of second abdominal segment usually joined or segment completely yellow; apical spot does not extend beyond second submarginal cell ..... 17
    Not with above combination of characters ..... 18
17. Second abdominal segment with a black spot or two black spots narrowly divided ..... *geminata* Wied.
    Second abdominal segment completely yellow
    *geminata impuncta* Krb.
18. Hyaline triangle reaches or nearly reaches second longitudinal vein (if subhyaline beyond bifurcation of third longitudinal vein, predominantly dark species with pale abdominal markings reduced) .... 19

Hyaline triangle scarcely extends beyond bifurcation of third longitudinal vein; predominantly yellowish species with dark abdominal markings ..... 20

19. Dark brown or fuscous with reduced pale abdominal markings *dacne* Philip

Yellow species with black abdominal markings ..... *beameri* Brennan

20. Abdomen with a median yellow stripe with a longitudinal black band on each side; lateral margins of segments narrowly yellow *univittata* Macq.

Abdomen yellow with four more or less complete rows of black spots ..... 21

21. Ground color of thorax and scutellum yellow ..... *vittata* Wied.

Ground color of thorax plumbeus; scutellum sometimes with some yellow ..... 22

22. Apical spot completely fills second submarginal cell; the sublateral rows of abdominal spots are about as dark as the median rows *aberrans* Philip

Apical spot not completely filling second submarginal cell; sublateral rows of abdominal spots paler than median rows ..... *striata* O.S.

## Key to the Species of Pennsylvania *Tabanus*

### I. Females

1. Vertex with an ocellar tubercle; eyes usually distinctly hairy subgenus *Hybomitra* End .... 2

Vertex without an ocellar tubercle; eyes bare or indistinctly hairy subgenus *Tabanus* L. ..... 14

2. Black species with first three abdominal segments mostly bright orange *cinctus* Fab.

Abdomen otherwise marked ..... 3

3. Abdomen without median stripe or triangles but with posterior margins of all segments with yellowish or whitish bands ..... *zonalis* Kirby

Abdomen with median markings ..... 4

4. Subcallus denuded and shining ..... 5

Subcallus pollinose ..... 7

5. Subcallus swollen; whole face below eyes denuded and shining; small species with dark wing markings ..... *hinei* John.

Subcallus normal; face below eyes not shining ..... 6

6. Eyes apparently bare; basal portion of third antennal segment narrow; abdomen brownish, faintly reddish brown laterally and with a median row of indistinct whitish triangles; wings unspotted *difficilis* Wied.

Eyes hairy; basal portion of third antennal segment not especially narrow; abdomen broadly orange-brown laterally; all cross veins strongly spotted with brown ..... *lasiophthalmus* Macq.

7. Abdomen broadly orange-brown laterally, the median black area usually constricted on the third segment ..... 8
   Abdomen not as above, if paler laterally median dark area of third segment is broad and not constricted ..... 10
8. Second palpal segment stout especially at base; frons distinctly widened above; third antennal segment usually entirely orange *epistates* O.S.
   Second palpal segment slender; frons parallel sided or slightly widened above; at least annuli of third antennal segment black ..... 9
9. Second palpal segment unusually slender, at least five times as long as greatest width; basal portion of third antennal segment about four fifths as wide as long and annulate portion rather short; hind tibial fringe black ..... *trepidus* McD.
   Second palpal segment moderately slender, not more than four times as long as greatest width; basal portion of third antennal segment not more than three fifths as wide as long and annulate portion relatively long; hind tibial fringe usually black but sometimes extensively yellow ..... *affinis aurilimbus* Stone
10. Abdomen black with a median row of distinct white triangles and no sublateral spots ..... *trispilus* Wied.
    Abdomen otherwise marked ..... 11
11. Second palpal segment slender, scarcely thickened at base ..... 12
    Second palpal segment stout, especially so at base ..... 13
12. Femora, except base of hind femora, brown; sides of abdomen reddish brown; base of third antennal segment rather slender and dorsal angle scarcely noticeable ..... *minusculus* Hine
    Femora black, occasionally dark brown; base of third antennal segment rather stout with distinct dorsal angle ..... *typhus* Whitn.
13. Legs nearly uniformly brownish, rarely femora somewhat darker; third antennal segment very slender; wings unspotted *microcephalus* O.S.
    All femora dark; third antennal segment stout; a dark spot at bifurcation of third longitudinal vein ..... *illotus* O.S.
14.(1) Abdomen unicolorous or with narrow indistinct posterior bands 15
    Abdomen with one or more median triangles or a median stripe ... 19
15. Subcallus denuded; body and wings entirely or almost entirely black; abdomen often with a whitish bloom ..... *atratus* Fab.
    Subcallus not denuded; wings at least partly clear ..... 16
16. Palpi pale to reddish brown; abdomen sometimes with traces of small median triangles .....*calens* L.
    Palpi dark brown to black ..... 17
17. Mesonotum dark brown ..... *nigrescens* Palisot
    Mesonotum white pollinose ..... 18
18. Frons orange-brown, moderate in width; wing veins not margined with brown although darker clouds may be present ..... *stygius* Say
    Frons gray, broad; wing veins margined with brown .. *subniger* Coqu.

19. Abdomen with a longitudinal median stripe which may or may not be widened at posterior margins of segments ..... 20
Abdomen with median markings not forming an uninterrupted stripe 27
20. Lateral markings forming a stripe on each side of median stripe and parallel to it but often shorter than median stripe; spots forming median stripe nearly parallel sided ..... 21
Lateral markings broken into separate, often roundish spots; spots forming median stripe usually widened at posterior margins of abdominal segments ..... 23
21. Costal cell deep yellow; thorax yellow pollinose; palpi yellow; frons nearly parallel sided; eye in life with a single purple band *quinquevittatus* Wied.
Costal cell usually clear; thorax grayish pollinose; palpi pale; frons widened above; eye in life with two purple bands ..... 22
22. Scutellum and thorax concolorous; femora mostly dark; median callus a narrow line ..... *lineola* Fab.
Scutellum reddish, sometimes faintly, on posterior margin; legs predominantly reddish; median callus short and widened *lineola scutellaris* Wlk.
23. Frons narrow, widened above ..... 24
Frons broader, parallel sided ..... 25
24. Gray-brown species; costal cell clear; basal portion of third antennal segment very narrow, dark yellow brown; palpi white *sackeni* Fairch.
Yellowish species; costal cell colored; basal portion of third antennal segment broader, bright orange; palpi yellow ..... *fulvulus* Wied.
25. Second palpal segment much swollen basally; median abdominal stripe broad ..... *sagax* O.S.
Second palpal segment not very swollen basally; median abdominal stripe narrow ..... 26
26. Pale markings of abdomen yellowish brown, the sublateral spots touching the hind margins of the segments ..... *sublongus* Stone
Pale markings of abdomen grayish, the sublateral spots small and usually separated from the hind margins ..... *longus* O.S.
27. Pale triangle on second abdominal segment smaller than those on two following segments or absent; scutellum with pale pile ..... 28
Pale triangle on second segment not smaller than those on two following segments; pile of scutellum not especially pale ..... 30
28. Pale triangle normally absent from second abdominal segment; fore tibiae bicolored ..... *trimaculatus* Palisot
Pale triangle on second abdominal segment normally present; fore tibiae uniform in color ..... 29
29. Abdominal triangles very small; scutellum about same color as mesonotum ..... *superjumentarius* Whitn.
Abdominal triangles large; scutellum paler than mesonotum *molestus* Say

30. Abdomen with both median and sublateral spots ..... 31
Abdomen without sublateral spots although abdomen may be paler laterally ..... 36
31. Bifurcation of third longitudinal vein with a dark spot; grayish species; basal callus almost square ..... *reinwardtii* Wied.
Bifurcation without a dark spot; color variable; basal callus higher than wide ..... 32
32. Small species, usually 12 mm. or less; frons widened above; costal cell hyaline ..... 33
Larger species, usually 13 mm. or more and differing in at least one other character from above ..... 35
33. Median callus large; palpi not swollen basally or sharply pointed; eye in life with two purple bands ..... *pumilus* Macq.
Median callus slender; palpi swollen basally but with apex acute; eye in life unicolorous or with a single purple band ..... 34
34. Eye unicolorous ..... *sparus* Whitn.
Eye with a single purple band ..... *sparus milleri* Whitn.
35. First antennal segment swollen above; sides of subcallus with a few hairs laterally; median abdominal triangles similar in size or slightly smaller than sublateral spots ..... *fairchildi* Stone
First antennal segment not swollen above; sides of subcallus without hairs; median abdominal triangles much smaller than sublateral spots ..... *nivosus* O.S.
36. Bifurcation of third longitudinal vein with a brown spot ..... 37
Bifurcation without a brown spot although veins may have indistinct brown margins ..... 38
37. Fore tibiae unicolorous; median abdominal spots long and narrow *recedens* Wlk.
Fore tibiae bicolored; median abdominal spots broad *sulcifrons* Macq.
38. Wings with a smoky tinge; costal cell heavily colored; large species with median triangles small or obsolete ..... 39
Wings hyaline; costal cell hyaline or slightly tinted; smaller species with conspicuous median triangles ..... 40
39. Third antennal segment reddish yellow; median abdominal triangles faint and arising from faint posterior bands; first posterior cell narrowed toward margin ..... *calens* L.
Third antennal segment partly black; median triangles small but distinct and not arising from bands; first posterior cell not narrowed *catenatus* Wlk.
40. At least fore tibiae bicolored; first posterior cell much narrowed and sometimes closed at wing margin; subcallus pollinose; usually over 15 mm. ..... *melanocerus* Wied.
Tibiae unicolorous although fore tibiae may be slightly paler at base; first posterior cell slightly or not at all narrowed at margin; subcallus thinly pollinose or denuded; usually under 15 mm. ... *nigripes* Wied.

## Key to the Species of Pennsylvania *Tabanus*

### II. Males

1. Stiff hairs along mid line between eyes ..... *difficilis* Wied.
   No stiff hairs along mid line between eyes ..... 2
2. Eyes hairy ..... 3
   Eyes bare ..... 16
3. Black species with first three abdominal segments bright orange *cinctus* Fab.
   Abdomen otherwise marked ..... 4
4. Abdomen without median stripe or triangles but posterior margins of segments with yellowish or whitish bands ..... *zonalis* Kirby
   Abdomen with median markings ..... 5
5. Small dark species with gray protuberant frontal triangle; genae black, somewhat shining; a dark cloud on wing near stigma .. *hinei* John
   Differing in one or more characters from the above ..... 6
6. Cross veins and bifurcation of third longitudinal vein with distinct dark spots ..... 7
   Wings hyaline, tinted or with bifurcation only with a dark spot ..... 8
7. Rather large grayish species with three rows of gray triangles on abdomen ..... *reinwardtii* Wied.
   Blackish species; sides of first three abdominal segments broadly orange ..... *lasiophthalmus* Macq.
8. First antennal segment strongly swollen above; hair on eyes sparse *fairchildi* Stone
   First antennal segment not swollen above; hair on eyes usually heavy 9
9. Abdomen black, obscurely reddish laterally but no distinct sublateral spots; a conspicuous row of white median triangles .. *trispilus* Wied.
   Abdomen otherwise marked ..... 10
10. Small speceis not over 12 mm. with very small slender second palpal segment; sides of abdomen broadly dark orange but first segment usually completely black; third antennal segment with a very shallow dorsal excision; prescutal lobe reddish ..... *minusculus* Hine
    Species usually over 12 mm. or if smaller, second palpal segment not especially slender and/or dorsal excision distinct; prescutal lobe variable ..... 11
11. Prescutal lobe black; femora brownish ..... *microcephalus* O.S.
    Prescutal lobe reddish at least on disc; femora normally black ..... 12
12. Abdomen broadly orange-brown laterally; median black area constricted on third abdominal segment ..... 13
    Abdomen not broadly orange laterally; orange-brown sublateral spots may be present but black area on third segment is not constricted ..... 15
13. Third antennal segment including annuli reddish; second palpal segment very stout, only slightly longer than thick .... *epistates* O.S.

Third antennal segment with at least annuli black; second palpal segment slender ..... 14

14. Large and small eye facets differentiated; second palpal segment very small ..... *trepidus* McD.

Almost no differentiation in size of eye facets; second palpal segment moderate in size ..... *affinis aurilimbus* Stone

15. Second palpal segment at least twice as long as thick; large and small eye facets distinctly differentiated ..... *typhus* Whitn.

Second palpal segment stout, less than twice as long as thick; eye facets nearly uniform in size ..... *illotus* O.S.

16(2). Abdomen unicolorous or with narrow indistinct pollinose bands .. 17

Abdomen with median markings ..... 21

17. Palpi orange-brown to yellow ..... *calens* L.

Palpi dark brown to black ..... 18

18. Wing completely black or very dark brown ..... *atratus* Fab.

Wing dilutely infuscated or nearly clear; a black spot at bifurcation of third longitudinal vein ..... 19

19. Lower margin of area of large eye facets somewhat sinuate and at lowest point about on level with top of antennal pits *subniger* Coqu.

Lower margin of large facets more nearly straight and somewhat higher than antennal pits ..... 20

20. Integument of thoracic dorsum brown, contrasting strongly with black abdomen; wing membrane, except for spots, rather uniformly dilutely infuscated ..... *stygius* Say

Integument of thoracic dorsum dark brown to black, usually contrasting but slightly with black abdomen; apex of wing, except for spots, almost hyaline ..... *nigrescens* Palisot

21. Abdomen with a longitudinal stripe which may or may not be somewhat widened at posterior margins of segments ..... 22

Abdomen with median markings not forming and uninterrupted stripe ..... 28

22. Lateral markings of abdomen forming a stripe on each side of median stripe and parallel to it but usually shorter than median stripe; spots forming median stripe nearly parallel sided ..... 23

Lateral markings broken into separate often roundish spots; spots forming median stripe usually wider at posterior margin of each segment ..... 25

23. Costal cell heavily infuscated; hair of head and thorax mostly yellow; prescutal lobe concolorous with mesonotum; annulate portion of third antennal segment as long or longer than basal portion *quinquevittatus* Wied.

Costal cell usually hyaline; hair of head and thorax mostly gray; prescutal lobe usually paler than rest of mesonotum; annulate portion of third antennal segment usually shorter than basal portion ..... 24

24. Scutellum and thorax concolorous ..... *lineola* Fab.
Scutellum reddish, sometimes faintly, on posterior margin *lineola scutellaris* Wlk.

25. Hair and pollen of pleura yellow; area of large and small eye facets scarcely differentiated ..... *fulvulus* Wied.
Hair and pollen of pleura gray; area of large and small facets distinctly differentiated ..... 26

26. Hair of thoracic dorsum gray; sublateral abdominal spots grayish; costal cell hyaline ..... *sackeni* Fairch.
At least short hairs of thoracic dorsum yellow; sublateral abdominal spots yellow; costal cell tinted ..... 27

27. Median abdominal stripe broad; face below eyes with many black hairs, beard yellowish white; second palpal segment stout, yellow brown with many black hairs ..... *sagax* O.S.
Median abdominal stripe narrow; face with almost no black hairs, beard pale gray; second palpal segment relatively slender, pale yellowish white with few black hairs ..... *sublongus* Stone

28. Abdomen with median spots or triangles and at least some segments with sublateral spots ..... 29
Abdomen with median spots or triangles; no distinct sublateral spots although some segments may be paler laterally ..... 33

29. First antennal segment swollen above; third antennal segment entirely black; eyes sometimes with sparse hairs ..... *fairchildi* Stone
First antennal segment not swollen; third antennal segment variable; eyes bare ..... 30

30. Fore tibiae entirely black; sublateral spots very large often crossing second and third abdominal segments; third antennal segment black *nivosus* O.S.
Fore tibiae paler at base; sublateral spots smaller rarely crossing any segment; third antennal segment not entirely black; small species 31

31. Tibiae same color as reddish brown to brown femora or slightly paler basally; antennae yellowish, often with annulate portion somewhat darker; basal portion of third antennal segment two and one half to three times as long as wide; occipital tubercle prominent and often projecting above level of eyes ..... *pumilus* Macq.
Tibiae distinctly paler than dark femora except apex of fore tibiae which is dark; antennae uniformly dull brownish; basal portion of third antennal segment about twice as long as wide; occipital tubercle inconspicuous and compressed, usually not reaching level of eyes .. 32

32. Eyes in life without stripes ..... *sparus* Whitn.
Eyes in life with a single purple stripe ..... *sparus milleri* Whitn.

33. Pale thorax sharply contrasting with dark abdomen which has distinct white median triangles on the third to fifth segments; fore tibiae bicolored ..... *trimaculatus* Palisot
Not with the above combination of characters ..... 34

34. Bifurcation of third longitudinal vein with a brown spot ..... 35
    Bifurcation without a brown spot ..... 36
35. Legs including fore tibiae uniformly brown; abdomen mahogany brown with very narrow elongate median white triangles .... *recedens* Wlk.
    Fore tibiae bicolored or at least paler at base; at least fore femora black; abdominal triangles broad ..... *sulcifrons* Macq.
36. Frontal triangle denuded and somewhat protuberant; abdominal triangles often indistinct; smaller species, usually under 13 mm. *nigripes* Wied.
    Frontal triangle not denuded; larger species, rarely smaller than 15 mm. and as large as 25 mm. ..... 37
37. Facets of eyes all about same size; median triangles very small *calens* L.
    Upper facets of eye larger than lower facets with line of demarcation distinct ..... 38
38. Scutellum covered with white pollen which contrasts with dark base of abdomen; median pale spot of second abdominal segment reduced in size; fore tibiae uniformly dark ..... *molestus* Say
    Not with the above combination of characters ..... 39
39. Median triangle usually absent from second abdominal segment or very small if present; large eye facets occupying about half total eye area ..... *superjumentarius* Whitn.
    Median triangle present on tergite two and about same size as those on tergites three and four; large eye facets occupying about two thirds of total eye area ..... 40
40. Femora dark brown or black; fore tibiae paler at base; excision of third antennal segment moderate; median abdominal spots fairly large *melanocerus* Wied.
    Femora orange-brown or chestnut brown; fore tibiae uniformly brown; excision of third antennal segment deep; abdomen uniformly dark brown with small median triangles ..... *catenatus* Wlk.

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## EXPLANATION OF FIGURES

### PLATE XI

Eye patterns of Tabanus

Fig. 1.—*T. lasiopthalmus* Macq. ♂
Fig. 2.—*T. lasiopthalmus* Macq. ♀
Fig. 3.—*T. difficilis* Wied. ♂
Fig. 4.—*T. difficilis* Wied. ♀
Fig. 5.—*T. reinwardti* Wied. ♂
Fig. 6.—*T. reinwardti* Wied. ♀
Fig. 7.—*T. lineola* Fab. ♂
Fig. 8.—*T. lineola* Fab. ♀
Fig. 9.—*T. quinquevittatus* Wied. ♂
Fig. 10.—*T. quinquevittatus* Wied. ♀
Fig. 11.—*T. cinctus* Fab. ♂
Fig. 12.—*T. cinctus* Fab. ♀
Fig. 13.—*T. atratus* Fab. ♂
Fig. 14.—*T. atratus* Fab. ♀
Fig. 15.—*T. sulcifrons* Macq. ♂
Fig. 16.—*T. sulcifrons* Macq. ♀
Fig. 17.—*T. sparus milleri* Whitney ♂
Fig. 18.—*T. sparus milleri* Whitney ♀
Fig. 19.—*T. lineola scutellaris* Walk. ♀
Fig. 20.—*T. trepidus* McD. ♀
Fig. 21.—*T. pumilus* Macq. ♀
Fig. 22.—*T. affinis aurilimbus* Stone ♀
Fig. 23.—*T. typhus* Whitney ♀
Fig. 24.—*T. nigrescens* P.d.B. ♀
Fig. 25.—*T. catenatus* Walk. ♀
Fig. 26.—*T. trispilus* Wied. ♀
Fig. 27.—*T. sulcifrons* Macq. ♀ lateral view
Fig. 28.—*Goniops chrysocoma* (O.S.) ♀

PLATE XII

Wing patterns of Chrysops

(drawing by Evelyn Wernham)

Fig. 1.—*C. callida* O.S.
Fig. 2.—*C. nigra* Macq.
Fig. 3.—*C. geminata* Wied.
Fig. 4.—*C. vittata* Wied.
Fig. 5.—*C. sackeni* Hine.
Fig. 6.—*C. moecha* O.S.
Fig. 7.—*C. wiedemanni* Krb.
Fig. 8.—*C. shermani* Hine.
Fig. 9.—*C. celer* O.S.
Fig. 10.—*C. univittata* Macq.
Fig. 11.—*C. carbonaria* Walk.
Fig. 12.—*C. inda* O.S.

PLATE XIII

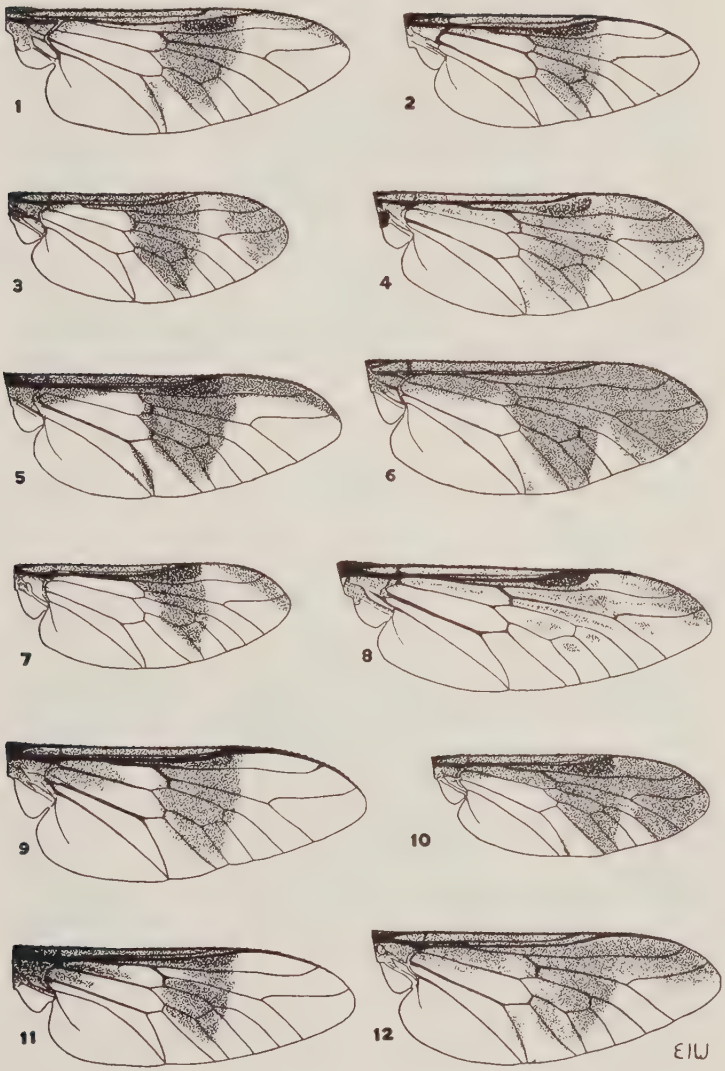
Upper Fig.—Beaver Dam, Centre County. A typical small pond. (Photograph by R. L. Campbell.)

Lower Fig.—Stony Fork, Tioga County. A rocky stream flowing through woods. (Photograph by R. L. Campbell.)

PLATE XIV

A spatter dock pond, the Barrens, Centre County.

FROST AND PECHUMAN: TABANIDAE OF PENNSYLVANIA




FROST AND PECHUMAN: TABANIDAE OF PENNSYLVANIA

FROST AND PECHUMAN—TABANIDAE OF PENNSYLVANIA

FROST AND PECHUMAN: TABANIDAE OF PENNSYLVANIA

# A REVISION OF THE GENUS MORSEA (ORTHOPTERA; ACRIDOIDEA; EUMASTACIDAE)

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In the preparation of the monograph of the Orthoptera of North America, which has been sponsored by the National Science Foundation, we have found it necessary to prepare preliminary or collateral papers on certain aggregations. In these the usually extensive available material and information is analyzed, and many unreported factual details are recorded, on which much of the greatly condensed monographic treatment is being, or will be, based. These studies are thus source publications, in that often extensive and involved data, later summarized in the more condensed monographic treatments, are placed on record, and thus made available to future analytical workers.

The present study of this endemic North American genus of the Eumastacidae is one of this category. The sole previous study of *Morsea* as a generic unit was that of Rehn and Hebard, published in 1918.[1] In addition to the information then presented we now have before us nearly double the material then available, and a much broader knowledge of the component subspecies of the single species of the genus (*M. californica*), this including their distribution and bionomics. The earlier paper should be consulted for considerable detailed discussion, descriptions of forms then known, and for numerous explanatory figures.

## MORSEA Scudder

1898. *Morsea* Scudder, Psyche, VIII, p. 179.
1918. *Morsea* Rehn and Hebard, Trans. Amer. Entom. Soc., XLIV, p. 226. (Study of genus.)

[1] Trans. Amer. Entom. Soc., XLIV, pp. 226-241, numerous illustrations.

Type of genus (by monotypy).—*Morsea californica* [i.e. *M. c. californica*] Scudder.

A full description of the genus was presented by Rehn and Hebard in the above-mentioned study. Except for one or two minor features, which have become apparent in the present work, the generic description then given fully, presents the more outstanding characters of the genus.

*Distribution.*—From west-central California (the Mount Tamalpais area) and the eastern base of the Sierra Nevadas in the Mono Lake region of the same state, east to the Horse Range in central-eastern Nevada, and the western base of the Tushar Range in southwestern Utah, south in the chaparral belt of the California Coast Range and adjacent intermontane lower levels to the San Gabriel and San Jacinto Mountains of southern California and portions of the lowlands at their bases, and to the Baja California border, and eastward in California into the San Bernardino Mountains and the Laguna escarpment bordering the Colorado Desert on the west; from the northern points given in eastern California and those in Nevada and Utah, the genus extends southward, apparently in suitable situations in sections of the Basin and Range Province (the classic "Great Basin"), to the mountains and plateaus of northern and central Arizona (as far south as Yarnell in Yavapai County) (see Map 1).

The genus is not a true desert inhabitant, the sole truly desert locality from which we have seen it being Mojave, California, near the western border of the Mojave Desert, a locality well known to us and very close to bordering hill slopes, on which, it is our feeling, the *Morsea* individuals were probably collected. It is not known from elsewhere in the Mojave Desert, nor from the Colorado or Yuma Deserts, and apparently it is absent from all of southern Arizona, and also does not occur to the eastward of the Coconino Plateau or the elevated area of central Arizona. Further, it is not present, as far as known, on any of the mountains or plateaus, or in any of the intervening valleys of the Cordilleran uplift in Utah east of the western foothills of the Tushar Range. It is not known from the interior valley of California nor from the higher levels of the Sierra Nevadas. We know nothing as to its occurrence in Baja California, or in

Mexico proper, but there can be no question but that it is found in at least the more northern, the San Pedro Martir, section of Baja California, as it has been taken at several Californian localities that are on the border. Its possible occurrence in Mexico proper seems much less certain, as we have no knowledge of its presence within one hundred and fifty miles (air-line distance) of the Arizona-Mexico border, although a large amount of field work has been done in the intervening country over the last half century. In a portion of southern Arizona its place seems to be taken by the related *Eumorsea*, although the latter is a dendrophilous, rather than a thamnophilous, entity. However, both *Morsea* and the related genus *Psychomastax* occur in some of the same general areas of California and Nevada, although their distributions are not coextensive.

*Remarks.*—In 1918 Rehn and Hebard regarded the single species of this genus as divisible into three subspecies, two of which were then evidenced as intergrading from the material then available. At this time the representation before us is virtually twice as large as that seen in 1918, and it indicates the presence of five component subspecies of *californica*. Extensive areas of Nevada and Utah, from which little material was available in 1918, are now represented by fair series, and the possession of these, as well as more ample representations from Arizona and parts of California, have necessitated a full resurvey of the systematics, and a broader discussion of the bionomics, of the genus.

As individuals of *Morsea* are slender, twig-like creatures, they are exceedingly delicate, and in capturing these elusive "hoppers" limbs or antennae are frequently lost, and later, in the handling of the fragile dried material, further casualties of this type are almost unavoidable. Hence completely perfect specimens are the exception rather than the rule.

The interrelations of the five components of *M. californica* have been well established by the present study. Except for intermediates between *M. c. kaibabensis* and *M. c. dumicola*, which are very closely related, we have examined individuals which demonstrate to our satisfaction the intergradation of the other subspecies. The ranges of *M. c. kaibabensis* and *M. c. dumicola*

are now separated by the Grand Canyon of the Colorado, so the presence of truly intermediate material could hardly be expected.

Relative to the possible original home of *Morsea,* Rehn and Hebard in 1918 (vide supra) gave as their opinion at that time: "It seems probable to us that the present distribution of the genus is due to two parallel lines of dispersal extending north from an original center in Mexico, where possibly the two forms [i.e. *c. californica* and *c. dumicola*], or others very closely related, will be found in intergrade. The absolute lack of Mexican information makes any further theorizing along these lines unwarranted at this time. Another possibility is that *Morsea* originally occurred in what is now the hot, arid Lower Sonoran Zone, and possibly in the mountains as well, that increasing aridity and temperature, with the competition of a new fauna and the elimination or great restriction of its preferred habitat, forced it into its present zonal position." The continuing absence of any Mexican information compels us to weigh anew the possibilities then discussed. While *M. c. californica* and *M. c. dumicola* are very similar, it is conceivable that the second hypothesis quoted above, i.e. that the genus may have developed from an ancestral stock, presumably now gone, which occurred during the Pleistocene or earlier in the low desert country now intervening between the ranges of the two forms mentioned above, is more logical than that the two have sprung from a common ancestor in Mexico. Further, the most generalized, and presumably most primitive, component of the species is *M. c. piute,* the present Basin and Range representative, while the lines represented by the other elements have their ranges separated by the Gulf of California and the low deserts flanking it on the north. The presence of the group on Santa Cruz Island, California, gives a fair antiquity to its occurrence in California. The only section of Mexico where it seems the genus may occur is that of the San Diegan and San Pedro Martir faunal districts of northern Baja California, as defined by Nelson.[2] Here we feel, if found, it has been intrusive from the north. Its absence from all of southern Arizona seems to pre-

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[2] "Lower California and Its Natural Resources." Mem. Nat. Acad. Sci., XVI, pp. 117-118, pl. 31 (1921).

clude its presence now in Sonora or Sinaloa. Less capable of maintaining itself in more boreal situations than its relative *Psychomastax,* but rarely is *Morsea* taken at elevations surpassing 7000 feet.

The zonal correlation of *Morsea* is basically Upper Sonoran, although it does at times enter the Transition Zone and bordering sections of the Lower Sonoran. Dependence upon, or at least preference for, certain host plants is as marked as with numerous other thamnophilous acridoid genera, although it has also been noted early in the day on the ground in their vicinity, and it is quite possible that there the nights are passed, the bush position and feeding being taken up as the day warms.

As in other of our studies which have dealt with closely related subspecies—the atypical conditions of each and intermediates between them and the evidence which definitely proves their subspecific character—we have found it practical to grade individuals or populations as typical of a certain subspecies, atypical of the same, or intermediate between particular subspecies, the latter sharing the characteristics of each to an approximately equal degree. This method of breaking down extensive representations into fairly recognizable categories has in practice been found logical, fairly presenting the facts, although necessarily based on a human equation.

In the present study a total of 518 specimens of *Morsea* have been studied, 419 of these in the collection of the Academy of Natural Sciences of Philadelphia, 31 in that of the University of Arizona, 20 the property of the California Academy of Sciences, 17 belonging to the American Museum of Natural History, 15 to the Museum of Zoology of the University of Michigan, 14 to the Museum of Comparative Zoology of Harvard College, and one each to the University of California, Los Angeles, and the University of Idaho. The total number of localities represented by the series studied is 81, which includes all which have been cited in previous literature.

## Key to the Subspecies of Morsea californica

(Based largely on the male sex and drawn from typical material of each of the forms)

1. Head in profile deeper longitudinally, subvertical measurement of head proportionately less; facial line in same view evenly low convex, not at all concave in the subfastigial-interocellar section; fastigio-facial angle as seen in profile essentially rectangulate;[3] eyes as seen in cephalic aspect more tumidly bullate laterad in proportion to the depth of the same; frontal costa as a whole broader in both sexes. (Curvature of the dorsal outline of the fastigium more sharply arcuate toward the fastigio-facial angle. Eyes in basal outline broadly ovate.) (Chiefly Basin and Range Province.)
*M. californica piute* new subspecies

Head in profile shallower longitudinally, subvertical measurement of head proportionately greater; facial line in same view sinuate to some degree, a subfastigial-interocellar subconcavity usually evident to varying degrees; fastigio-facial angle as seen in profile more acute, more prominent; eyes as seen in cephalic aspect less tumidly bullate laterad in proportion to the depth of the same; frontal costa as a whole narrower in both sexes 2

2. Eyes as seen in cephalic aspect somewhat less prominent. Cephalic and median limbs, particularly femora, more slender and attenuate. Caudal femora more attenuate distad ..... 3

Eyes as seen in cephalic aspect somewhat more prominent. Cephalic and median limbs, particularly femora, not as slender nor as attenuate. Caudal femora less attenuate distad ..... 4

3. Head in profile higher and narrower (longitudinally), the acute fastigio-facial angle sharper and more produced. In cephalic aspect the head as a whole is broader, particularly the infra-ocular section, the lateral borders of which are subparallel. Antennae of ♂ with distal section more strongly spatulate. (Cerci of male always strongly falcate recurved distad.) (Mt. Tamalpais area of Marin Co., California.[4])
*M. californica tamalpaisensis* Rehn and Hebard

Head in profile not as high and somewhat deeper (longitudinally), the fastigio-facial angle, while acute, less produced. In cephalic aspect the head as a whole is narrower, particularly the infra-ocular section, the lateral borders of which are somewhat converging dorsad toward the eyes. Antennae of ♂ with distal section less strongly spatulate. (Mountains of southern California.) ..... *M. californica californica* Scudder

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[3] In weighing this angulation the axis lines of the angles are considered without reference to the circumambient carinae, which are often somewhat elevated above their bearing surfaces.

[4] The summarized distributions given in this key are presented merely as convenience aids, and are only of typical material. Full discussion of individual distributions, that of atypical and of intermediate representations are given under the treatment of each subspecies.

4. Antennae of ♂ with distal articles somewhat more strongly dilated, more spatulate. Dorsal outline of occiput and fastigium somewhat more strongly convex toward the fastigio-facial angle.[5] Basal outline of eye of ♂ more ovate. (Kaibab Plateau, northern Arizona.)
*M. californica kaibabensis* new subspecies

Antennae of ♂ with distal articles less definitely dilated, less spatulate. Dorsal outline of occiput and fastigium evenly low arcuate, not accentuating toward the fastigio-facial angle. Basal outline of eyes of ♂ more elliptical. (Coconino Plateau and mountains of central Arizona.)
*M. californica dumicola* Rehn and Hebard

**Morsea californica californica** Scudder Text-figs 1-16.

[*Morsea*] *californica* Scudder, Psyche, VIII, p. 179 (1898) [♂; Mt. Wilson, California (type locality selected by Rehn and Hebard, 1918[6]); Cahon [Cajon] Pass, California]: Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., 1909, p. 420, figs. 6 and 7 (1909) [Mt. Lowe, Echo Mountain and Mt. Wilson, California].

*Morsea californica californica* Rehn and Hebard, Trans. Amer. Entom. Soc., XLIV, p. 229, pl. XI, fig. 2, pl. XII, figs. 2, 6, 10, 12, 16, 18, and 20, pl. XIII, figs. 2, 6, 8, and 10 (1918) [full discussion with selection of allotypic ♀].

In 1918 Rehn and Hebard (vide supra) presented full descriptions of both sexes of this subspecies, there selecting a lectotypic male and indicating as the allotypic female one from Mt. Lowe in the San Gabriel Range, a peak which is about two miles due west of the type locality—Mt. Wilson. The two original specimens of *M. c. californica* are immature males, now in the collection of the Museum of Comparative Zoology. Topotypic adults of both sexes are now before us in the Academy series.

The differential characters of the other subspecies of *californica* have been presented in the preceding key and further discussion is given under the respective forms.

*Morphological variation.*—As already pointed out by Rehn and Hebard in 1918 (p. 234) there is in this nominate subspecies considerable variation in the form, breadth, and degree of production of the fastigium, even in individuals of the same sex from the same locality. The degree of truncation of the fastigium

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[5] This shows some individual variation, but is a good average feature for the subspecies.

[6] Trans. Amer. Entom. Soc., XLIV, p. 229.

as seen from the dorsum also shows a fair range. As seen in profile there similarly is considerable variation in the exact angle of the fastigio-facial angle, although it is never as acute as in the greater majority of the individuals of *M. c. tamalpaisensis,* nor as rectangulate as in *M. c. piute.* The bullation of the eyes, particularly in the male sex, and the exact proportions and shape of the ovate basal outline of the eyes also vary somewhat individually, these being rather more bullate and more broad ovate in basal outline in individuals from the several localities represented on the southern slopes and upper levels of the San Gabriel Range (Echo Mountain, Mt. Lowe and Mt. Wilson) than in those from most other localities. In those with

Measurements (in millimeters) of extremes on representative individuals (♂)

| | Length of body | Length of antenna | Length of pronotum | Length of cephalic femur | Length of median femur | Length of caudal femur |
|---|---|---|---|---|---|---|
| Typical M. cal. californica | | | | | | |
| Echo Mtn., Calif. | 9.6 | 2.3 | 1.5 | 2.4 | 2.2 | 7.4 |
| Echo Mtn., Calif. | 10.4 | 2.3 | 1.6 | 2.7 | 2.3 | 8.4 |
| Mt. Lowe, Calif. | 11.4 | 2.4 | 1.7 | 2.9 | 2.6 | 9.0 |
| Mt. Lowe, Calif. | 12.2 | --- | 2.2 | 3.7 | 3.3 | 10.4 |
| Mt. Wilson, Calif. | 11.0 | 2.8 | 1.9 | 3.2 | 2.9 | 9.0 |
| Verdemont, Calif. | 8.6 | 1.8 | 1.5 | 2.3 | 2.0 | 7.4 |
| Verdemont, Calif. | 11.5 | 2.5 | 1.8 | 2.8 | 2.5 | 8.3 |
| Atypical M. cal. californica | | | | | | |
| San Marcos Pass, Calif. | 10.2 | 3.0 | 1.8 | 3.3 | 3.0 | 8.8 |
| San Marcos Pass, Calif. | 11.2 | 2.8 | 2.0 | 3.1 | 3.1 | 10.2 |
| Near head of Mint Canyon, Calif. | 10.1 | 2.0 | 1.7 | 2.3 | 2.2 | 7.5 |
| Near head of Mint Canyon, Calif. | 12.7 | --- | 2.0 | 3.0 | 2.3 | 9.1 |
| Harvey's, Mill Creek, Calif. | 10.2 | 2.5 | 1.7 | 2.5 | 2.3 | 8.3 |
| Harvey's, Mill Creek, Calif. | 10.8 | 2.3 | 2.2 | 2.8 | 2.5 | 9.7 |
| Intermediate bet. M. cal. californica and M. cal. tamalpaisensis | | | | | | |
| Del Monte, Calif. | 8.2 | --- | 1.4 | 2.7 | 2.3 | 7.6 |
| Del Monte, Calif. | 10.5 | 2.7 | 1.5 | 2.8 | 2.4 | 8.5 |
| Roscoe, Tujunga Wash, Calif. | 11.2 | 2.0 | 1.7 | 2.4 | 2.3 | 8.4 |
| Roscoe, Tujunga Wash, Calif. | 11.0 | 2.3 | 1.7 | 2.8 | 2.5 | 9.0 |
| Intermediate bet. M. cal. californica, M. cal. tamalpaisensis and M. cal. piute | | | | | | |
| Parker Mtn., Calif. | 12.4 | 2.5 | 1.8 | 2.8 | 2.3 | 8.5 |
| 2 ms. NE. of Vincent, Calif. | 11.6 | 2.0 | 2.0 | 2.3 | 2.2 | 8.2 |

Table 1. Size variation in males of *Morsea californica californica* and intermediates between *M. c. tamalpaisensis* and *M. c. piute.*

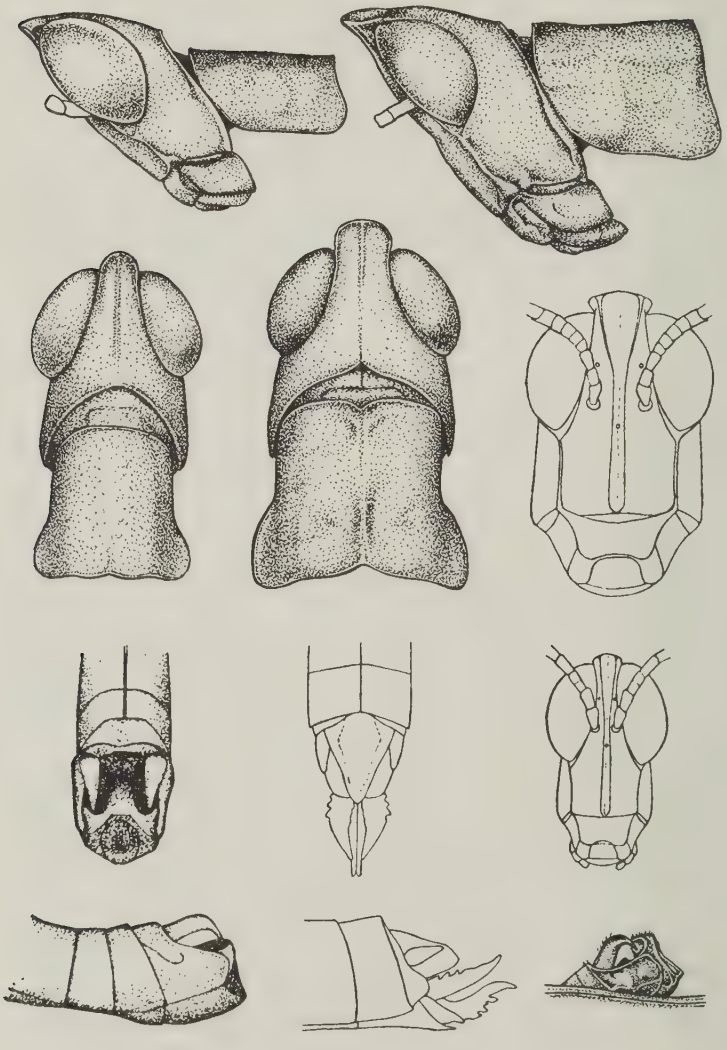
the more bullate eyes, the whole cephalic outline of the head is altered to some degree. The facial outline as seen in profile shows some variation in the exact emphasis of the shallow inter-antennal convexity in the male sex, and of the weak infra-fastigial concavity of the female.[7] The antennae vary somewhat in length (see tables 1 and 2), but are usually uniform within a population, while the expansion of the distal articles in the males is occasionally less marked in some individuals than in others, and its maximum development is less than that of typical *M. c. tamalpaisensis.* There is an appreciable amount of

Measurements (in millimeters) of extremes on representative individuals (♀)

| | Length of body | Length of antenna | Length of pronotum | Length of cephalic femur | Length of median femur | Length of caudal femur |
|---|---|---|---|---|---|---|
| Typical M. cal. californica | | | | | | |
| Echo Mtn., Calif. | 12.5 | --- | 1.6 | 2.1 | 2.7 | 10.2 |
| Echo Mtn., Calif. | 15.4 | 2.0 | 2.1 | 2.6 | 3.4 | 12.2 |
| Mt. Lowe, Calif. | 16.5 | 2.6 | 2.6 | 3.4 | 3.5 | 12.2 |
| Mt. Lowe, Calif. | 19.0 | 2.2 | 2.2 | 2.9 | 3.1 | 12.0 |
| Verdemont, Calif. | 14.6 | 1.7 | 2.0 | 2.2 | 2.2 | 9.3 |
| Verdemont, Calif. | 14.0 | 1.7 | 2.0 | 2.3 | 2.3 | 9.6 |
| San Jacinto Mts., Calif. | 15.1 | 1.8 | 2.5 | 2.2 | 2.6 | 11.5 |
| Warner, Calif. | 18.0 | 2.6 | 2.5 | 2.8 | 2.2 | 12.1 |
| Resort P.O., Laguna Mts., Calif. | 17.0 | 1.8 | 2.2 | 2.5 | 2.5 | 10.5 |
| Atypical M. cal. californica | | | | | | |
| San Marcos Pass, Calif. | 17.6 | 2.3 | 2.6 | 3.1 | 3.1 | 11.3 |
| Near head of Mint Canyon, Calif. | 17.9 | 2.2 | 2.5 | 2.5 | 2.5 | 9.7 |
| Harvey's, Mill Creek, Calif. | 17.4 | 2.0 | 2.3 | 3.0 | 3.0 | 11.0 |
| Harvey's, Mill Creek, Calif. | 21.2 | 2.3 | 2.6 | 2.8 | 3.1 | 11.6 |
| Intermediate bet. M. cal. californica and M. cal. tamalpaisensis | | | | | | |
| Del Monte, Calif. | 15.5 | 1.9 | 1.8 | 2.6 | 2.4 | 8.6 |
| Del Monte, Calif. | 16.8 | 2.2 | 2.0 | 2.7 | 2.6 | 9.2 |
| Roscoe, Tujunga Wash, Calif. | 16.1 | 1.4 | 1.5 | 2.3 | 2.2 | 9.4 |
| Roscoe, Tujunga Wash, Calif. | 18.8 | 2.0 | 2.3 | 2.5 | 2.6 | 10.8 |
| Intermediate bet. M. cal. californica, M. cal. tamalpaisensis and M. cal. piute | | | | | | |
| Downer's Ranch, E. base of Mt. Piños, Calif. | 19.9 | 2.2 | 2.6 | 2.8 | 3.0 | 11.2 |
| 2 ms. NE. of Vincent, Calif. | 18.3 | 2.0 | 2.6 | 2.5 | 2.8 | 10.8 |

Table 2. Size variation in females of *Morsea californica californica* and intermediates between *M. c. tamalpaisensis* and *M. c. piute.*

[7] In teneral individuals this infra-fastigial concavity is often greatly exaggerated by chitin buckling.



variation in the degree to which lateral carinulae are present on the pronotum in the male sex, the Echo Mountain males (7) alone showing a range from reasonably well marked to completely unindicated. The cerci of the male show a considerable range in the sharpness and degree of decurvature of the distal extremity. However, this latter fluctuation is not evident in individual populations, which are relatively fixed in this respect, but the extreme conditions are quite decided. The males from 3 ms. NW. of Beaumont exhibit the most sharply decurved cercal apices, in this respect fully equalling the cercal form figured in 1918 by Rehn and Hebard for *M. c. tamalpaisensis*.[8] We have figured a specimen of this type from Echo Mountain (see fig. 10).

The limbs vary somewhat in length, this particularly true of the cephalic and median ones. This tendency in *M. c. californica* appears to be a character of individual populations. The longest caudal femora are found in material from the San Gabriel Range, the shortest in the series from Verdemont in Cajon Wash on the south side of Cajon Pass. While the latter lot averages smaller than those from the San Gabriel Range, the femoral length is not directly correlated with the general size or bulk. It is quite probable adaptation is the explanation for this condition and that what we see is a correlation of limb length to the general

[8] Trans, Amer. Entom. Soc., XLIV, pl. XIII, fig. 11.

Figs. 1-11.—*Morsea californica californica* Scudder. All from Mt. Lowe, California (except fig. 10): fig. 1 (upper left), lateral view of head and pronotum of ♂ (×10); fig. 2 (left on second row), dorsal view of same (×10); fig. 3 (upper right), lateral view of head and pronotum of ♀ (×10); fig. 4 (center of second row), dorsal view of same (×10); fig. 5 (right of third row), cephalic outline of head of ♂ (×6); fig. 6 (left of third row), dorsal view of apex of abdomen of ♂ (greatly enlarged); fig. 7 (left of bottom row), lateral view of same (greatly enlarged); fig. 8 (center of third row), dorsal view of apex of abdomen of ♀ (greatly enlarged); fig. 9 (center of bottom row), lateral view of the same (greatly enlarged); fig. 10 (right of bottom row), lateral view of apex of abdomen of ♂, Echo Mountain, California (greatly enlarged); fig. 11 (right of second row), cephalic outline of head of ♀ (×9).

character of the foliage and twig structure of the plant frequented at the individual localities, or at least the type of plant growth permitted there by controlling factors. A representative male from Mt. Lowe in the San Gabriel Range [9] has the cephalic femur 3.29 mm. long, the median 2.86, and the caudal 9.36, while one from Verdemont has the same parts respectively 1.98, 1.88, and 6.56 in length.

*Size variation.*—The appended tables (tables 1 and 2) of measurements present the size range found in this subspecies. The purely individual range in single populations is seen to be considerable, and sometimes this is marked in both sexes. As suggested above, it is always possible in thamnophilous genera such as *Morsea* that the relative length of the limbs may reflect the growth form and the physical make-up of the twigs and foliage of the host plant at the respective localities. The great dependence of this genus on its host plant is fully evident to one who is familiar with it in its preferred habitats. While its saltatorial ability is most remarkable, its adroitness in maintaining the position for launching its powerful jump is due to the cephalic and median limbs being able to preserve its stance.

*Coloration, tone and pattern.*—Rehn and Hebard in 1918 [10] gave a detailed analysis of these features in this subspecies, and to this the student is referred. The much larger series now available does not make necessary any important modification of the comments then made. The buffy dorsum, then mentioned as seen in females from Roscoe, California, is also noticed in individuals of that sex from Mt. Wilson, Verdemont, Harvey's on Mill Creek, and from Mill Creek at 5200-5500 feet, while the females from Lebec, Cuyama Ranch and Downey's Ranch, as well as one of those from San Marcos Pass, are quite uniformly pale buffy, as are numerous of the immature individuals. Males with the dorsum buffy are present in the Verdemont and Harvey's on Mill Creek series, as well as those from three miles NW. of

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[9] This is the specimen figured by Rehn and Hebard, Trans. Amer. Entom. Soc., XLIV, pl. XI, fig. 2, pl. XII, figs. 2, 10, 12, and 16, pl. XIII, figs. 8 and 10 (1918).

[10] Trans. Amer. Entom. Soc., XLIV, pp. 232-233.

Beaumont and from near the head of Mint Canyon. This pale dorsum may be a genetic feature. Specimens from the desert (north) side of the San Bernardino Range average uniformly much paler than others, as does the single female from near Baldwin Lake in the same mountains.[11] The much more extensive series from several localities along Mill Creek, on the southern side of the same range, and from Cactus Flat, a deserty bench at 5900 feet [12] on the northern face of the same mountain mass, average no paler than series from the San Gabriel Range and other localities.

*Distribution.*—As shown by Rehn and Hebard in 1918 [13] this, the nominate subspecies, intergrades northward into *M. c. tamalpaisensis.* At that time it was considered that typical material of *M. c. californica* occurred as far north as Paso Robles, in San Luis Obispo Co., California. This conclusion we find, on the basis of the much more extensive representation now available, requires modification. The influence of the sharper-headed, narrower-eyed *M. c. tamalpaisensis* extends much farther than then believed, and we now regard the representations before us from a number of localities in Monterey, San Benito, San Luis Obispo, Kern, Santa Barbara, and even points in northwestern Los Angeles County as intermediate between *M. c. californica* and *M. c. tamalpaisensis.* From the knob of mountain country made up of the Mt. Piños group and the Ventura Range the limited representation shows tendencies in three directions, i.e. toward *M. c. californica, M. c. tamalpaisensis,* and *M. c. piute.* From the Santa Inez Range, the Sierra Pelona, the Verdugo Hills, the higher levels of the Cajon Pass, and localities in the San Bernardino Mountain mass all individuals seem to be atypical of *M. c. californica.* Material from localities in the San Gabriel Range, that from the southern approach to the Cajon

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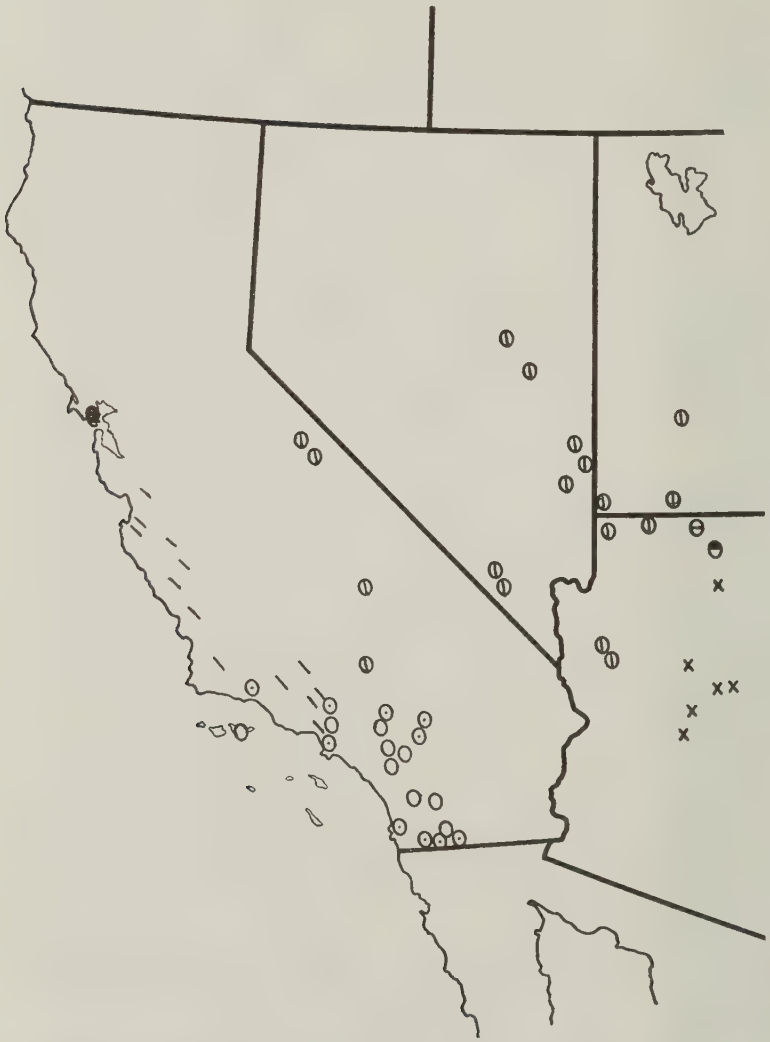
[11] It is possible all of these, none of which was personally collected by us, have had their coloration altered by preservation or too lengthy containment in a killing bottle. The latter quickly destroys color in desert heat.

[12] For the position of the latter locality, as well as textual comments on the character of it, see Grinnell, "The Biota of the San Bernardino Mountains," Univ. of Cal. Publ. Zool., V, no. 1, pp. 20-21, pl. 1 (map) (1908).

[13] Trans. Amer. Entom. Soc., XLIV, pp. 227, 234.



Map 1. The distribution of the subspecies of *Morsea californica*. Open circles = typical *M. californica californica;* circles with center dot = atypical *M. californica californica;* filled circles = typical *M. californica tamalpaisensis;* circles with vertical center line = typical *M. californica piute;* circles

Pass (Verdemont), from the western side of the San Gorgonio Pass (3 ms. NW. of Beaumont), the San Jacinto Mountains, and from certain higher elevations in San Diego County are typical *M. c. californica.* Along the Mexican border section of San Diego County, which averages lower than some of the other localities in the same county represented by material, the material is clearly atypical. We know nothing regarding *M. californica* from Baja California, Mexico, in the northern part of which it most certainly occurs, in at least the general uplift of the San Pedro Martir. It is possible a distinct subspecies is there present, and that the atypical character of individuals from along the border section of California [14] is due to an influence from the southward.

From present evidence *M. c. californica* does not enter the Lower Sonoran Colorado Desert, although it extends eastward nearly or quite to the summit of the western mountain border of that desert near Beaumont, at Resort Post Office, Laguna Mountains, and at Jacumba.

The area embraced in the distribution of typical and atypical *M. c. californica* as known to us, thus extends from San Marcos Pass in the Santa Inez Mountains, in Santa Barbara County, California, eastward over the Sierra Pelona, San Gabriel and San Bernardino ranges definitely as far as the upper Mill Creek section on the southern slopes of the last mentioned mountain group, and southward, at suitable stations to the California-Baja California border, eastward as far as Jacumba, San Diego Co. A subspecifically indeterminable immature individual of this species is before us from Santa Cruz Island, California, which shows the presence of the genus in the Channel Islands, and thus aids in understanding the history of the genus in California.

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[14] Most of the localities represented (i.e. Campo, Potrero, and Jacumba) are but a few miles from this border. Conditions at all of these localities are personally known to the senior author.

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with horizontal center line = atypical *M. californica piute;* circle with upper half filled = typical *M. californica kaibabensis;* crosses = typical *M. californica dumicola;* oblique line = intermediate records of *M. c. tamalpaisensis, M. c. californica,* and *M. c. piute.*

The elevations represented by material of *M. c. californica* extend as high as 7000 feet, at the W. end of Baldwin Lake in the San Bernardino Mountains, to at least 6100 feet on Mt. Lowe in the San Gabriel Range, 5900 feet at Cactus Flat, 6100 feet at Resort P. O., Laguna Mountains, and material intermediate between this subspecies and *M. c. tamalpaisensis* and *M. c. piute* has been taken as high as 6400 feet at " Bear Trap " at the east foot of Mt. Piños. The lowest exact elevations we have are 1700 feet at Verdemont, and 825 feet at Roscoe in the Tujunga Wash. We have no elevation for the specimens labelled " San Diego " and " San Gabriel," the former of which could have been from virtually sea-level and the latter slightly higher than 400 feet, but these specimens conceivably could have been taken at somewhat higher levels in the general vicinity of both places.

*Habitats.*—In 1918 Rehn and Hebard [15] stated that this insect is " a chaparral inhabitant, never really abundant, and in actions it is extremely nimble and vigorous. The chaparral components from which it has been taken are: chamisal (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos tomentosa*) and Nuttall's Ceanothus (*Ceanothus cuneatus*). It has also been taken on *Eriogonum polifolium* in a desert wash at Roscoe. The usual location of the insect is perched in an exposed position on the upper portions of the bushes, with the caudal limbs strongly diverging and the short antennae erect. Their saltatorial powers are highly developed and they are not at all easy to capture. Constantly on the alert as they are, a swift sweep of the net is the most successful method of securing them." This statement holds true for our much broader knowledge today, with the added facts that it also has been taken on mountain mahogany (*Cercocarpus betulifolia*) along Mill Creek at 5200-5600 feet, and also on bitter bush (*Purshia tridentata*) at " Bear Trap " at the east base on Mt. Piños, 6400 feet, where this plant grew on slopes with open stands of pine and some oak, with smaller areas of sage and manzanita. It is generally found on chamise (*Adenostoma fasciculatum*), occasionally on dead as well as living bushes, often not at all common and secured only by long continued search or beating. It was taken on the ground but

[15] Trans. Amer. Entom. Soc., XLIV, pp. 233-234.

once (at Downer's Ranch), among dry weeds, but close to manzanita growing among pinyon on granite gravel hill slopes. There it may have been flushed from manzanita which is one of its host plants.

*Seasonal Appearance.*—The earliest dates for which we have adults are June 29 (Lebec, Kern Co.), July 22 (Sargent, Santa Clara Co.), 24 (Lockwood, Monterey Co.), and 29 (NE. base of San Bernardino Mountains, and Baldwin Lake in the same range). Warner, San Diego Co. is represented by a July individual, but without date, and adult material from the San Jacinto Mountains was taken July 31. The latest date we have for adult material is November 8 (Santa Monica Mountains). Very small immature individuals before us were taken as early as April 29 (Pinyon Flat and 3 ms. NW. of Mountain Center, San Jacinto Mountains), and material in the instar preceding maturity was secured July 25 at Cuyama Ranch, Santa Barbara Co. Adult and immature individuals were taken together on June 29 at Lebec, Kern Co., but most of the other dates represented by both types of individuals were in August, with one as late as September 2 (Verdemont)—with most of the specimens taken then being adult.

*Remarks.*—The complicated intergrading of the elements of this species, which is evidenced by material before us from Los Angeles County and areas to the west of it, undoubtedly reflects biotic changes of the recent past. The interdigitation of what might be called the Coast Range influence (intermediate between *M. c. californica* and *M. c. tamalpaisensis*), that of the San Gabriel and San Bernardino uplift (largely typical *M. c. californica*), and the intrusive Great Basin tincture (reflected in the tendency toward *M. c. piute*) is not as puzzling as it may seem. As long ago as 1905 the great master of Californian biotics, the late Joseph Grinnell, noted in his study of the birds of Mt. Piños [16] that " owing to the excessive aridity of the region, perhaps accounted for by the ocean air-currents being cut off by intervening mountain ranges, the vegetation of the plateau region immediately surrounding Mount Piños has a decidedly

[16] The Auk, XXII, p. 380.

Great Basin aspect." This tendency is reflected in the *Morsea* occurring there and the same is also seen in material taken years ago on Parker Mountain at the southeastern end of the Ventura Range and above Soledad Canyon, which latter in some of its life aspects has a strong Mohavan tincture. This Mohavan strain appears to have been able to make itself felt to some degree as far into the more truly Southern Californian coastal district as Roscoe in the Tujunga Wash [17] of the San Fernando Valley, and westward along the relative arid course of the Santa Maria River as far as Cuyama Ranch.

*Localities represented:* [18]

### Typical *M. c. californica*

California: *Echo Mountain, San Gabriel Range, 2700-3500 ft. (15), *Mt. Lowe, San Gabriel Range, 5000-6100 ft. (10), *Mt. Wilson, San Gabriel Range, 5000 ft. (3), San Gabriel (1) (Los Angeles Co.). Verdemont, 1700 ft. (San Bernardino Co.) (18). 3 ms. NW. of Beaumont, 2540 ft. (10), San Jacinto Mts. (2), *Coahuila (1), 3 ms. NW. of Mountain Center, San Jacinto Mts., 4800 ft. (1), Pinyon Flat, San Jacinto Mts., 4050 ft. (1) (Riverside Co.). *Nellie (2), Warner (1), and Resort P. O. Laguna Mts., 6100 ft. (2) (San Diego Co.).

### Atypical *M. c. californica*

California: San Marcos Pass, Santa Inez Mts. (Santa Barbara Co.) (9). Santa Monica Mts. (1), near head of Mint Canyon, Sierra Pelona, 3500 ft. (16), and *Verdugo, Verdugo Hills, 750-900 ft. (2) (Los Angeles Co.). Cajon Pass, hills on desert side, 4000 ft. (2), Cajon Canyon 1.5 ms. NE. of Cajon, 3750 ft. (3), Cactus Flat, San Bernardino Mts., 5900 ft. (3), Harvey's, Mill Creek, San Bernardino Mts., 3700 ft. (13), Mill Creek, San Bernardino Mts., 4200 and 5200-5500 ft. (3), San Bernardino Mts., base of NE. (desert) side (4), San Bernardino Mts., S. slope 4900 ft. (1), and W. end of Baldwin Lake, San Bernardino Mts., 7000 ft. (1) (San Bernardino Co.). San Diego (1), Campo (4), Potrero (1) and Jacumba (1) (San Diego Co.).

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[17] The former distinctive conditions of the Roscoe environment have probably been in great part destroyed by the spread of metropolitan Los Angeles. However, what these were when Rehn and Hebard collected there in 1909 can be understood from the environment photograph then made and published in their 1918 study (Trans. Amer. Entom. Soc. XLIV, pl. XV, fig. 1).

[18] As in other recent studies by the authors an asterisk preceding a locality indicates that it has been published in previous literature.

Intermediates between *M. c. californica* and *M. c. tamalpaisensis*

CALIFORNIA: Sargent (Santa Clara Co.) (1). Monterey (1), *Del Monte (50), Priest Valley, Diablo Range, 2500-2700 ft. (1), and Lockwood (1) (Monterery Co.). Pinnacles National Monument, Gabilan Range, 1200 ft. (San Benito Co.) (1). *Paso Robles, 900-1100 ft. (San Luis Obispo Co.) (1). Lebec (Kern Co.) (5). Cuyama Ranch, Santa Maria River (Santa Barbara Co.) (1). *Roscoe, Tujunga Wash, 825 feet (Los Angeles Co.) (4).

Intermediate between *M. c. californica, M. c. tamalpaisensis* and *M. c. piute*

CALIFORNIA: Downer Ranch, Mt. Piños, 5200-5400 ft. (1), and "Bear Trap," east base of Mt. Piños, 6400 ft. (1) (Ventura Co.). *Parker Mountain, SE. end of Ventura Mts., 2800-4100 ft. (2), and 2 ms. NE. of Vincent, 3000 ft. (3) (Los Angeles Co.).

*M. californica* subsp. ?

CALIFORNIA: Santa Cruz Island (Santa Barbara Co.) (1 juv.).

**Morsea californica tamalpaisensis** Rehn and Hebard Text-figs. 12-17.

*Morsea californica tamalpaisensis* Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., 1909, p. 421, figs. 3, 4, and 5 (1909) [♂, ♀; Mt. Tamalpais, Marin Co., California]: Rehn and Hebard, Trans. Amer. Entom. Soc., XLIV, pp. 229, 239, pl. XII, figs. 4, 8, and 14, pl. XIII, figs. 4 and 11 (1918) [selection of lectotype (♂) and extensive discussion].

Of the features previously given as diagnostic of this subspecies we now know that the strongly falcate and subrecurved form of the distal portion of the male cerci is also found in *M. c. californica,* and there is much variation, particularly in the latter subspecies, in this respect. However, the average more protuberant fastigium, especially of the male, when seen from the dorsum is a feature of *M. c. tamalpaisensis* when compared with *M. c. californica,* as well as its less prominent and less deep eyes which also have their basal outline appreciably subacute dorsad, and as a whole more ovoid rather than broad elliptical, while its male antennae are more spatulate distad. In some of these latter respects *M. c. tamalpaisensis* agrees with other subspecies of *californica,* but in those cases of similarity in some features other differences are evident.

The selected lectotype (Academy of Natural Sciences of Philadelphia, Type no. H 12) and the allotype, as well as the

greater part of the original paratypic series, are now before us.

The female sex of the present subspecies is not strongly characterized when compared with the same sex of the other subspecies, but the profile of the fastigial production and the sharpness of its fastigio-facial angle, when compared with those of *M. c. californica,* should enable one to distinguish it. The facial outline, as seen in profile, is flatter and less convex interantennally, its more dorsal concavity usually somewhat more clearly indicated, and the whole head is more shallow (i.e. longitudinally) with the entire facial line more appreciably retreating ventrad. The ventral surface of the ventral ovipositor valves of the female is somewhat broader proximad and more excavate transversely between the marginal teeth than in *M. c. californica.*

*Morphological variation.*—While there is some minor variation in the exact proportions of the basal outline of the eyes in this subspecies, it is uniformly more ovoid (or truly egg-shaped), narrower and more subacute dorsad than in *M. c. californica,* while the eyes are also appreciably less protuberant or bullate in both dorsal and cephalic views. The facial profile in the male shows similarly some little range in the strength of its interantennal convexity, and also of the shallow concavity of the same outline between the interantennal region and the fastigio-facial angle. In the female sex the facial outline shows almost no variation. The relative acuteness of the fastigio-facial angle, as seen in profile, is somewhat variable in both sexes, but it is always more decided than in the other subspecies of *californica.* The distal spatulation of the antennae in the male is always marked, the expansion greatest on the fourth or fifth article from the apex, its greatest breadth usually subequal to half the distance from the apex to the base of the fifth article from the same. The frontal costa is quite narrow in the male sex, particularly in the median section, rarely faintly widened about the median ocellus. In the female sex the broader frontal costa is not noteworthily variable. The outline of the fastigium as seen from the dorsum is usually well rounded in the male, but occasionally subtruncate mesad.

The male cerci are always of the strongly falcate type originally given as a characteristic of this subspecies but which, we

now know, also occurs in *M. c. californica.* Male material intermediate between *M. c. californica* and *M. c. tamalpaisensis* always has the cercus as sharply decurved distad as found in typical *M. c. tamalpaisensis.* The median cephalad directed process of the subgenital plate of the male varies somewhat in breadth in this, as in other subspecies of *californica,* but it here is always relatively narrow.

*Size variation.*—The maximum and minimum dimensions (in millimeters) known for this subspecies are:

| | Length of body | Length of antenna | Length of pronotum | Length of cephalic femur | Length of median femur | Length of caudal femur |
|---|---|---|---|---|---|---|
| ♂, Mt. Tamalpais, California, *type* ..... | 10.2 | 2.5 | 1.8 | 3.1 | 2.7 | 8.2 |
| ♂, Mt. Tamalpais, California ..... | 10.9 | 2.8 | 1.6 | 2.7 | 2.5 | 8.0[19] |
| ♀, Mt. Tamalpais, California, *allotype* ..... | 14.0 | 1.8 | 2.1 | 2.7 | 2.6 | 9.5 |
| ♀, Mill Valley, California ..... | 21.4 | 2.3 | 2.6 | 3.3 | 3.4 | 11.0 |

*Coloration, tone and pattern.*—In 1918 Rehn and Hebard (p. 240) compared the coloration of this subspecies with that of *M. c. californica.* As noted then, no individuals are before us now with complete or solid darker longitudinal lateral bars. The general tone varies through shades of gray-brown or gray, overlaid with fuscous, occasionally, however, the whole body being ochraceous-buff or apricot buff, more rarely as dark as kaiser brown (of Ridgway). The buffy or brownish individuals are in all cases females or immature specimens, while the bulk of the females average as dark, and as largely fuscous, as in the males, without, however, the usual relieving pale gray tone of the face, the ventral section of the lateral lobes of the pronotum and of the pleura seen in virtually all the males. The caudal femora show some variation in the solidity and emphasis of the trans-

[19] Some males from the same locality with lesser body length have caudal femora as long as 8.5 and 8.7 mm.

verse darker bars, which, however, are usually, but not invariably, absent from the brownish or buffy individuals. Also the immature individuals, which are almost always pale, very largely lack the darker bars.

*Distribution.*—Typical *M. c. tamalpaisensis* is at present known only from the general region of Mt. Tamalpais, in Marin County, California, immediately north of San Francisco (see map 1). It has been taken at stations ranging from Mill Valley, but a few hundred feet above sea-level at the southeast base of Mt. Tamalpais, to the summit of the East Peak of the same mountain at 2586 feet elevation. On Mt. Tamalpais itself it has been reported from elevations between 1100 and the 2586 foot summit, with the majority of the material before us taken at 2400 feet. Like other members of the genus, and probably other Nearctic eumastacids, the distribution of this subspecies is doubtless made up of numerous localized populations, occurring in favorable or preferred habitats, and with considerable intervening areas of present non-occurrence. The host plants from which *M. c. tamalpaisensis* has been reported are both regarded as Upper Sonoran types by Hall and Grinnell.[20]

*Habitats.*—The exact published information on habitats of this subspecies is that given by the collectors of the original material, Rehn and Hebard, in 1909 and 1918. This was summarized in the latter year as follows: "The Tamalpaisan form frequents the thick low chaparral from 1100 to 1500 elevation, and the heavier, more arborescent chaparral from 1500 feet to the summit (2586 feet) of Mount Tamalpais. The principal components of this chaparral are chamisal (*Adenostoma fasciculatum*) and manzanita (*Arctostaphylos glandulosa*), on both of which *Morsea* occurs as commonly and as vigorous and active as in Southern California." A photograph of the Mt. Tamalpais habitat was given by Rehn and Hebard in their 1918 account of the forms of *Morsea*.[21]

*Seasonal Appearance.*—In 1918 Rehn and Hebard said of *M. c. tamalpaisensis* it would "be fair to assume that the first in-

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[20] "Life-Zone Indicators in California." By H. M. Hall and J. Grinnell. Proc. Cal. Acad. Sci., (4) IX, no. 2, (1919).

[21] Trans. Amer. Entom. Soc., XLIV, pl. XV, fig. 2.

dividuals reach maturity some time before August 17," the latter being the earliest date represented by their adult material. A single adult female from Mill Valley, now before us, was taken as early as August 7. The latest exact date represented by adults now before us is of a single male secured December 14 at Mill Valley. The latest date for an adult female is of one from Mill Valley taken October 8. All the Mt. Tamalpais material was taken in August (17, 1909 and 23, 1909) except for one female secured September 19.

*Localities represented:*

CALIFORNIA: *Mt. Tamalpais (45) and Mill Valley (14) (Marin County).

**Morsea californica piute**[22] new subspecies Text-figs. 18-22.

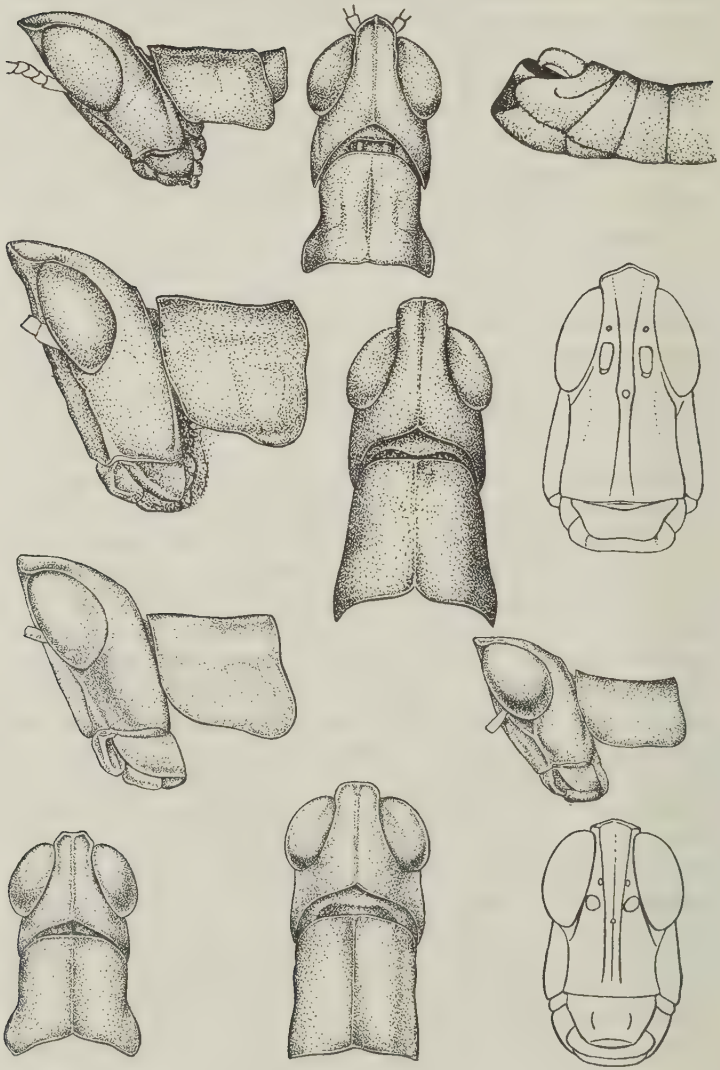
*Morsea californica dumicola* Rehn and Hebard, Trans. Amer. Entom. Soc., XLIV, p. 235 (1918) (In part only.) [Solely the records from Crestline and Caliente, Nevada.]

This subspecies differs from *M. c. californica* in the even convexity of the whole facial profile in the male, as well as the less produced and more rectangulate profile of the fastigio-facial angle in both sexes. The eyes of the male sex, as seen in cephalic aspect, are also appreciably more bulbous than in typical *M. c. californica*. The relationship to *M. c. kaibabensis* is closer than to *M. c. californica*, but the broader head, the average more rectangulate fastigio-facial angle (as seen in profile), and the more evenly convex character of the entire facial profile should serve to distinguish typical *M. c. piute* from *M. c. kaibabensis*, as well as from *M. c. californica*.

*Type.*— ♂ ; 1 mile N. of Current Summit, Horse Range, White Pine County, Nevada. Elevation, 7350 feet. August 28, 1924. (Rehn and Hebard.) [Academy of Natural Sciences of Philadelphia, Type no. 5809.]

*Description of Type.*—Head as seen in lateral aspect with somewhat greater depth longitudinally (i.e. thicker in that dimension) than in either *M. c. californica* or *M. c. kaibabensis*, the profile of the face without a definite subfastigial shallow concavity, as in *M. c. californica*, this entire outline more uniformly low convex; fastigio-facial angle as seen in profile

[22] After the Piute people, a dominant Indian stock of the Basin and Range (" Great Basin ") Province.



rectangulate, as contrasted with a more acute one in both *M. c. californica* and *M. c. kaibabensis*. In cephalic view the head is somewhat shorter, and proportionately somewhat broader ventrad of the eyes than in *M. c. californica*, in this respect more nearly resembling *M. c. kaibabensis*. Eyes in basal outline, as seen in profile broad ovate, in proportion to the head as a whole slightly shorter (dorsoventrad) than in *M. c. californica*. Antennae with the distal spatulation as in *M. c. californica* and narrower than in *M. c. kaibabensis*.

Cerci with the distal portion regularly decurving, not sharply hooked.

Cephalic and median limbs proportionately somewhat shorter than in *M. c. californica* or *M. c. kaibabensis*, rather more robust, caudal femora somewhat less attenuate and less slender distad than in *M. c. californica*, in this respect nearly as in *M. c. kaibabensis*.

*Allotype.*—♀; same locality and date as type. [Academy of Natural Sciences of Philadelphia.]

*Description of Allotype.*—Head seen in lateral aspect, as in the male sex, of somewhat greater depth longitudinally (i.e. thicker in that dimension) than in *M. c. californica*, its facial profile as a whole shallowly more convex than in either that subspecies or *M. c. kaibabensis*, and with no distinct subfastigial concavity, which is also indicated to some degree in the females of *M. c. kaibabensis*; fastigio-facial angle as seen in profile but faintly sharper than a right angle, appreciably less acute than in the same sex of *M. c. californica* and *M. c. kaibabensis*. In profile the basal outline of the eye is somewhat shorter and broader than in either *M. c. californica* or *M. c. kaibabensis*.

Cephalic and median limbs somewhat shorter and more robust proportionately than in *M. c. californica* or *M. c. kaibabensis*.

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Figs. 12-17—*Morsea californica tamalpaisensis* Rehn and Hebard. All of topotypes, unless otherwise indicated, from Mt. Tamalpais, California: fig. 12 (upper left), lateral view of head and pronotum of ♂ (×10); fig. 13 (upper center), dorsal view of same (×10); fig. 14 (upper right), lateral view of apex of abdomen of ♂ (*type*) (greatly enlarged); fig. 15 (left of second row), lateral view of head and pronotum of ♀ (×10); fig. 16 (center of second row), dorsal view of same (×10); fig. 17 (right of second row), cephalic outline of head of female (×10).

Figs. 18-22.—*Morsea californica piute* new subsp. All of paratypes. One mile E. of Current Summit, Nevada: fig. 18 (right of third row), lateral view of head and pronotum of ♂ (×10); fig. 19 (left of fourth row), dorsal view of same (×10); fig. 20 (left of third row), lateral view of head and pronotum of ♀ (×10); fig. 21 (center of fourth row), dorsal view of same (×10); fig. 22 (right of fourth row), cephalic aspect of head of same individual (×10).

*Morphological variation.*—As in the other subspecies of *M. californica* there is some individual variation in the exact angle of the fastigio-facial angle as seen in profile, which infrequently may be very slightly sharper than the much more usual right angle, and thus an approach to what is seen in *M. c. californica.* However, the evidently greater longitudinal dimension of the head, and the more broadly convex facial outline permits the proper reference of material which has a more variant fastigio-facial angle. The exact convexity of the facial profile also shows some little variation, the curvature being somewhat more accentuated in some individuals, particularly males, than in others, but the more broadly extended character of the convexity of the face is outstanding and well-marked in the greater majority of this subspecies. None of the males, except the single one from Mojave, California, shows the strongly rounded " bill-hook " type of apex of the cerci seen in most males of *M. c. tamalpaisensis,* and variably in *M. c. californica,* the distal curvature in the vast majority of *M. c. piute* being regularly arcuate. The relatively shorter cephalic and median femora in this subspecies shows but a slight degree of variation, which apparently is correlated with the general size range. The rather stouter distal section of the caudal femora, when compared with the somewhat more attenuate one of *M. c. californica* and *M. c. kaibabensis* is not strongly marked but apparently constant.

In quite a few morphological features every population exhibits some slight shade of difference from the next, and only in cases where a good representation, and of reasonably perfect material, is available—something very difficult to secure with these very fragile insects—can we be fully certain we have population tendencies and not purely individual ones.

*Size variation.*—The accompanying series of measurements (tables 3 and 4), chiefly of extremes of both sexes, give a clear idea of the considerable individual range in size found in the series of typical material of this subspecies now before us. Further, they appear to indicate that the average minimum size of *M. c. piute* is present at the northern and western peripheries of its range (i.e. Mojave, California, 1 m. N. of Current Summit, Caliente and Crestline, Nevada), while the maximum sized in-

dividuals are from localities in northern Arizona and adjacent Utah, even including the extreme northeastern point (South Ridge, Beaver Co., Utah) from which the subspecies, and also the genus *Morsea*, is known. However, atypical material of *M. c. piute* from Fredonia, Arizona, and its vicinity shows a particularly marked range in individual size, probably reflecting the influence of *M. c. kaibabensis* which occurs but a short distance southward, and higher, on the northern escarpment of the Kaibab Plateau, and under conditions quite different from those of the Fredonia area.

Measurements (in millimeters) of extremes on representative individuals (♂)

| | Length of body | Length of antenna | Length of pronotum | Length of cephalic femur | Length of median femur | Length of caudal femur |
|---|---|---|---|---|---|---|
| Typical M. c. piute | | | | | | |
| Mojave, California | 9.6 | 1.7 | 1.5 | 2.3 | 2.2 | 6.9 |
| S. of Sherwin Hill, Mono Co., California | 10.5 | 1.8 | 1.7 | 2.0 | — | 7.4 |
| Lee Canyon, Charleston Range, Nevada | 10.1 | 2.2 | 1.5 | 1.8 | 1.8 | 6.4 |
| Lee Canyon, Charleston Range, Nevada | 10.1* | 2.3 | 1.7 | 2.3 | 2.2 | 7.9 |
| 1 m. N. of Current Summit, Horse Range, Nevada, paratype | 8.3* | 2.2 | 1.7 | 2.2 | 2.2 | 7.2 |
| 1 m. N. of Current Summit, Horse Range, Nevada, type | 9.3 | 2.3 | 1.7 | 2.3 | 2.3 | 8.5 |
| 1 m. N. of Current Summit, Horse Range, Nevada, paratype | 9.4 | 2.2 | 1.5 | 2.5 | 2.2 | 8.0 |
| Crestline, Nevada | 9.0 | — | 1.4 | 2.0 | 1.8 | 7.2 |
| Crestline, Nevada | 10.0 | 1.9 | 1.5 | 2.2 | 2.0 | 7.3 |
| Caliente, Nevada | 11.1 | — | 1.5 | 2.2 | 2.1 | 7.8 |
| Road summit, Beaver Dam Mts., Utah | 11.2 | 2.5 | 1.8 | 2.6 | 2.3 | 8.5 |
| Road summit, Beaver Dam Mts., Utah | 11.2 | 2.6 | 1.8 | 2.8 | 2.5 | 8.8 |
| Littlefield, Arizona | 10.1 | — | 1.5 | 2.2 | 2.0 | 7.5 |
| Mesa E. of Mt. Murphy, Arizona | 11.0 | 2.3 | 1.7 | 2.5 | 2.3 | 8.3 |
| Kingman, Arizona | 10.8 | 2.5 | 1.8 | 2.6 | 2.3 | 8.5 |
| Deans Peak, Hualpai Mts., Arizona | 12.1 | 2.8 | 1.7 | 2.8 | 2.6 | 9.3 |
| Sawmill Canyon, Hualpai Mts., Arizona | 11.0 | 2.3 | 1.8 | 2.8 | 2.3 | 8.6 |
| Atypical M. c. piute | | | | | | |
| Fredonia, Arizona | 11.8 | 2.3 | 1.7 | 2.3 | 2.3 | 8.0 |
| 3 ms. S. of Fredonia, Arizona | 7.5* | 1.8 | 1.5 | 2.0 | 2.0 | 6.7 |
| 3 ms. S. of Fredonia, Arizona | 10.2 | 2.2 | 1.7 | 2.5 | 2.3 | 8.2 |

* Apex of abdomen much upcurved, hence actual body length (straight line) somewhat greater.

Table 3. Size variation in males of *Morsea californica piute*.

Measurements (in millimeters) of extremes on representative individuals (♀)

| | Length of body | Length of antenna | Length of pronotum | Length of cephalic femur | Length of median femur | Length of caudal femur |
|---|---|---|---|---|---|---|
| Typical *M. c. piute* | | | | | | |
| Mojave, California . . . . . | 15.1 | 1.7 | 2.0 | 2.2 | 2.3 | 7.9 |
| Lee Canyon, Charleston Range, Nevada . . . . . | 13.8 | 2.2 | 2.8 | 2.5 | 2.3 | 9.3 |
| 1 m. N. of Current Summit, Horse Range, Nevada, allotype . . . . . | 16.7 | 1.8 | 2.2 | 2.3 | 2.3 | 9.0 |
| 1 m. N. of Current Summit, Horse Range, Nevada, paratype . . . . . | 16.4 | 2.2 | 2.2 | 2.2 | 2.5 | 9.4 |
| Crestline, Nevada . . . . . | 14.5 | 1.8 | 2.0 | 2.0 | 1.9 | 8.5 |
| Crestline, Nevada . . . . . | 16.0 | 1.7 | 2.0 | 2.1 | 2.2 | 8.9 |
| Caliente, Nevada . . . . . | 13.3 | 1.5 | 1.7 | 2.2 | 2.2 | 9.0 |
| Caliente, Nevada . . . . . | 14.3 | 1.6 | 2.1 | 2.2 | 2.2 | 9.3 |
| South Ridge, Utah . . . . . | 18.4 | 2.0 | 2.2 | 2.5 | 2.3 | 9.0 |
| Road summit, Beaver Dam Mts., Utah . . . . . | 18.6 | 2.2 | 2.2 | 2.5 | 2.5 | 9.0 |
| Road summit, Beaver Dam Mts., Utah . . . . . | 19.5 | 2.0 | 2.3 | 2.6 | 2.6 | 9.9 |
| Littlefield, Arizona . . . . . | 17.8 | 2.0 | 2.2 | 2.3 | 2.5 | 10.1 |
| Sawmill Canyon, Hualpai Mts., Arizona . . . . . | 18.4 | 2.0 | 2.0 | 2.5 | 2.5 | 9.6 |
| Atypical *M. c. piute* | | | | | | |
| Fredonia, Arizona . . . . . | 18.4 | 2.0 | 2.2 | 2.5 | 2.3 | 9.3 |
| Fredonia, Arizona . . . . . | 20.8 | 2.0 | 2.3 | 2.5 | 2.5 | 10.2 |
| 3 ms. S. of Fredonia, Arizona | 14.2 | 1.7 | 1.8 | 2.2 | 2.3 | 8.3 |
| 3 ms. S. of Fredonia, Arizona | 16.7 | 2.0 | 2.0 | 2.3 | 2.3 | 9.4 |

Table 4. Size variation in females of *Morsa californica piute.*

*Coloration, tone and pattern.*—We find in *M. c. piute* much the same range of color pattern noted by Rehn and Hebard [23] for *M. c. californica.* In males the darker postocular bars are almost always evident, sometimes very strongly marked, and extremes ranging from almost no dark bars to these strongly indicated are seen in the same populations, as shown by those from the type locality, and the road summit over the Beaver Dam Mountains, Utah. Most of the males from Crestline, Nevada show at most but little indication of these dark bars, only one of the six having them clearly evident, while the single male from Caliente virtually lacks any trace of these bars. The Kingman and Littlefield, Arizona males virtually lack the dark bars, while the two males from the Hualpai Mountains southeast of Kingman have them evident.

[23] Trans. Amer. Entom. Soc., XLIV, pp. 232-233, (1918).

Numerous individuals are quite buffy in their general tone, these generally females. The allotype and paratypic female are of this tone, also that from Pogonip Ridge, Nevada, in fact most of the adult females are much paler than the average for the species, except that the bulk of those from the road summit over the Beaver Dam Mountains, Utah, and that from Littlefield, Arizona, are, as a whole, definitely fuscous. One female from Caliente, Nevada is very pale buffy, and the other of the same sex from there is largely fuscous. The female from Sawmill Canyon, Hualpai Mountains, Arizona is dull rufescent, as is another from the road summit over the Beaver Dam Mountains, and that from South Ridge, Utah.

A contrastingly pale longitudinal dorsal body bar is present in one female from Caliente, Nevada, and in another of the same sex from the road summit over the Beaver Dam Mountains, Utah, and the same is less strongly indicated in one female from Crestline, Nevada. One color type, found with both a general dark fuscous coloration and with the pale dorsal bar, has the caudal margin of the lateral lobes of the pronotum contrastingly creamy white or pale buff. This is seen in one otherwise fuscous female from Caliente, Nevada, in two similarly toned females from the road summit over the Beaver Dam Mountains, Utah, and one female with the pale dorsal bar from the same locality. The pale areas on the lateral lobes, as well as the pale dorsal bar, are probably genetic intraspecific features.

Almost all of the atypical individuals from Fredonia, Arizona are in general buffy brown, the males entirely so, the females varying from this to uniformly fuscous in several, while the pale dorsal bar is weakly evident in two females, and the pale area on the lateral lobes of the pronotum in two others. The general pale tone of these specimens could be correlated with the general conditions in the Fredonia area, which is largely open semi-arid plains with strong sunlight and very limited areas of the preferred plant cover.

*Paratypic series.*—In addition to the type and allotype we are designating twelve males and one female from the type locality, and bearing the same supplementary data, as paratypes.

*Distribution.*—This form inhabits the Basin and Range Province (i.e. "Great Basin") from the eastern base of the Sierra Nevada Range in the Mono Lake region of eastern California, to the western foothills of the Tushar Range in Beaver County, Utah (South Ridge), and from as far north as the former locality, and the Horse Mountains of White Pine County, Nevada southward to the vicinity of Kingman and the Hualpai Mountains of northwestern Arizona, narrowly crossing the Utah-Arizona boundary to the eastward (see map 1). From Fredonia, which is about four miles south of the Utah-Arizona boundary, and from a few miles south and southeast of the same place, material varying to an atypical condition, but with none which would be called direct intermediates between *M. c. piute* and *M. c. kaibabensis,* has been examined. In this latter area *Morsea* occurs in but limited suitable spots over the Prismatic Plains, between the Vermilion Cliffs on the north and the slopes of the Kaibab Plateau on the south, on which latter *M. c. kaibabensis* is found. This subspecies also occurs southeast of the Colorado River in Mohave County, Arizona, but then generally at lower levels than where that stream has cut through the definitely higher Kaibab-Colorado plateaus. The highest elevations from which we know *M. c. piute* are 7500 in Pumice Valley, Mono County, California, and 7625 feet on Pogonip Ridge, White Pine Co., Nevada; the lowest 1640 feet at Littlefield, Arizona in the valley of Virgin River, 3280 feet at Kingman, Arizona, and 3645 feet at Cartago, California, near the sink of Owen's River.

Zonally this subspecies is basically Upper Sonoran, narrowly entering the Lower Sonoran (Mojave, California, Virgin River valley and Kingman, Arizona), and reaching into the Transition Zone along the eastern base line of the Sierra Nevadas, in upper Kyle Canyon in the Charleston Range and near Current Summit, Nevada, as well as in the upper levels of the Hualpai Range in northwestern Arizona.

*Habitats.*—Rehn and Hebard in 1918 reported that *Morsea* at Caliente, Nevada was taken on *Kunzia tridentata* (now *Purshia tridentata*) on mountain slopes arising from the wash of Meadow Valley, and at Crestline, Nevada, "it was quite numerous on the same bush growing in open stands of Utah Juniper (*Juniperus*

*utahensis*) and occasional pinyon (*Pinus monophylla*) on the rolling plateau summit of the Juniper Mountains." Observations on this subspecies made since at more than a dozen localities show that its preference is largely for *Purshia* (" bitter brush " or " antelope brush "), on which the senior author has taken it at localities reaching from as far north as Pumice Valley, California, Pogonip Ridge, Nevada, and South Ridge, Utah, south to others in Kyle Canyon, in the Charleston Range, southern Nevada, and three miles south of Fredonia, Arizona. In most cases it was noted as beaten from *Purshia* and found nowhere else. Occasionally it was mentioned, in field notes, as " beaten from sage " (one mile north of Current Summit, Nevada), or " swept in an area of sage and rabbit weed in juniper at the foot of bordering cliffs " (East entrance to Zion National Park, Mt. Carmel road, Utah). It is probable that in these cases the *Morsea* may have been flushed from nearby *Purshia*, although this cannot be proven.

The general conditions under which the preferred host plant grew were varied. At three miles south of Fredonia, where the species was not at all common, it occurred on *Purshia* growing in patches on very low knolls scattered over the broad open plains stretching between the foot of the Vermilion Cliffs and the northern escarpment of the Kaibab Plateau, and where the associated shrubbery was chiefly rabbit weed (various composites) and low sage. At Spring Valley, 25 miles north of Pioche, Nevada, and where *Morsea c. piute* was taken, *Purshia* was found sparingly associated with juniper and sage, while at the road pass over the Beaver Dam Mountains, its host *Purshia* was growing under park-like junipers. At Pumice Valley, which is a small flat of volcanic ash enclosed by low lava hills, nestled under the Sierran ridge, the host plant also occurred with sage and rabbit weed. In Lee Canyon, at 6000 feet, on the east face of the Charleston Range, Nevada, *M. c. piute* was found at the upper portion of the tree yucca belt, where its preferred host plant was found with a scattering of pinyon and juniper and a ground cover of sage (*Artemisia tridentata*).

Usually *M. c. piute* was not numerous, and most of the series taken by Rehn and Hebard, or by the former alone, during eight

seasons at nineteen of the stations listed herewith, represent the results of lengthy search and intensive beating work, the most certain method of locating *Morsea* at any locality.

*Seasonal Appearance.*—The earliest date we have represented by adult material of *M. c. piute* is May 28, by a single male taken at Cartago, in the low southern portion of Owen's Valley, California. The next dates before us for adults are in late July (23 at Fredonia, Arizona, and 31 at 4000 feet on the Beaver Dam Mountains of extreme southwestern Utah). At Mojave, California, its most western known locality, it was taken adult on August 10, and all the other dates for adults are in August or the first half of September, with the last date represented being September 12 at South Ridge, Utah, the most eastern known locality for the subspecies.

Exceedingly small immature individuals have been taken as early as May 25, at the south end of Long Valley, on the lower eastern slopes of the Sierras, June 1 in upper Kyle Canyon, Charleston Range, Nevada at 7200 feet, and June 2 at the road summit over the Beaver Dam mountains, Utah. Immature individuals representing later instars are before us taken as late as August 16, at the south end of Pumice Valley, and south of Sherwin Hill, California, both stations along the east base of the Sierras between the Mono Lake region and Owen's Valley. Adult males and immature individuals of both sexes have been taken together on August 2 in Kyle Canyon, Charleston Range, Nevada, at 6500 feet. The subspecies possibly occurs adult well along into late Autumn, the absence of records probably due to the lack of collecting over its range after mid-September. On the other hand, frost may terminate the season's activities over most of its territory by early October.

*Remarks.*—We have already discussed under *M. c. californica* the tendency toward this subspecies seen in material from several localities in Ventura and Los Angeles County, California. Material from the western section of the Mojave Desert, in the vicinity of Mojave, is typical of *M. c. piute.* The elevation at which the Mojave material was taken is not given, but we question that *Morsea* will be found reaching broadly and regularly across the Mojave Desert to the eastward. Knowing the Mojave

vicinity rather intimately, it is possible it was collected to the north on the somewhat higher southern slopes of the Tehachapi Pass where tree yucca is a dominant feature of the vegetation.

The relative uniformity of this subspecies is evident from the eastern base of the Sierra Nevada, in the Mono Lake area, in suitable locales across the breadth of the Basin and Range Province (the classic "Great Basin") to the western foot of the Tushar Range (South Ridge) in Beaver County, Utah. The only evidence of intergradation with its more southern confreres is seen in material from Fredonia and two and three miles south or southeast of Fredonia, Arizona. From Fredonia we have seen eight males and nine females, of which all eight males and two of the females are typical *M. c. piute*, while seven females are definitely tending toward the *kaibabensis-dumicola* line of the species in their shorter (longitudinally) heads, less convex facial profiles and more acute fastigio-facial angles. Two males from two miles southeast of Fredonia are typical *M. c. piute*, while all six males and three of the six females from three miles south of the same point are similarly typical, and three females are atypical. In consequence, intergradation is intimated with *M. c. kaibabensis* which is found less than twenty miles distant from these points, but at higher elevations and in a relatively different general environment, although on or near the same host plant.

*Localities represented:*

### Typical *M. c. piute*

CALIFORNIA: Mojave (Kern Co.) (2). S. end of Pumice Valley, 7.5 ms. SSE. of Leevining, 7500 feet (1),[24] S. end of Long Valley at McGee Creek Pack Station, 6835 feet (1),[24] S. of Sherwin Hill, N. of Round Valley, 6000 feet (1), Round Valley (2) (Mono County). Cartago (Inyo Co.) (1).

NEVADA: Lee Canyon, Charleston Mountains, 6100 feet (6), Kyle Canyon, Charleston Mountains, 6500 feet (7), Kyle Canyon immediately below Charleston Park, 7250 feet (1) (Clark Co.). 1 m. N. of Current Summit, 7350 feet (14), Current Summit, 7300 feet (1), Pogonip Ridge, 7625 feet (1) (White Pine Co.). Spring Valley, 25 ms. N. of Pioche, 6150 feet (3), *Crestline, 6000 feet (9), *Caliente, 5200 feet (5) (Lincoln Co.).

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[24] Immature, but referred here by agreement of certain characteristics, and that of adult material from nearby areas with typical Nevada individuals.

UTAH: South Ridge, 10 ms. S. of Beaver, 6750-7000 feet (Beaver Co.). (1). E. entrance (Mt. Carmel road) to Zion National Park, 5800 feet (Kane Co.) (1). Road summit over Beaver Dam Mountains, 4700-4750 feet (13), Beaver Dam Mountain pass at first tree yuccas (presumably at lower border of same on southwest side), 4000 feet (1) (Washington Co.).

ARIZONA: *Littlefield (3), Mesa E. of Mt. Murphy,[25] 5400 feet (2), Kingman (1), summit of Dean's Peak, Hualpai Mountains (1), Sawmill Canyon, Hualpai Mountains (2) (Mohave Co.).

### Atypical *M. c. piute*

ARIZONA: Fredonia (17), 2 and 3 miles S. and SE. of Fredonia (12) (Coconino Co.).

**Morsea californica kaibabensis**[26] new subspecies Text-figs. 23-26.

This apparently localized subspecies is closely related to *M. c. dumicola,* the type locality of which is Prescott, in central Arizona. It agrees with *M. c. dumicola* in having the fastigio-facial angle more acute, when seen in profile, than in *M. c. piute,* and also in having the head shorter in its longitudinal dimension, and hence proportionately deeper, while the facial profile in its entirety is nearer that of *c. dumicola,* and not of the full convex type seen in *M. c. piute.* It differs from *M. c. dumicola,* chiefly in the male sex, in the slightly thicker (longitudinally) head, not quite as subacute fastigio-facial angle as seen in profile, in the basal outline of eye in the same sex being more ovate than elliptical, and with the dorsal and ventral sections of this outline more broadly rounded and less subangulate. In the female sex *M. c. kaibabensis* has the dorsal fastigial and occipital outline more arcuate than in the same sex of *M. c. dumicola,* and the basal outline of the eye is broader and shorter, thus exhibiting the same tendency seen in the male sex. These two subspecies are very close, clearly have had a relatively recent common origin, and are well differentiated from *M. c. piute* found to the northward.

*Type.*— ♂ ; Northwest escarpment slope of Kaibab Plateau,

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[25] Mt. Murphy is near Short Creek, and about three miles S. of the Utah state line.

[26] From the Kaibab Plateau of northern Arizona, lying immediately north of a portion of the Grand Canyon of the Colorado, and to which area this subspecies may be restricted.

Coconino County, Arizona.[27] Elevation, 6700 feet. September 3, 1926. (Rehn and Hebard.) [Academy of Natural Sciences of Philadelphia, Type no. 5810].

*Description of Type.*—Head as seen in lateral aspect with somewhat greater depth longitudinally (i.e. thicker in that dimension) than in *M. c. dumicola* and hence more shallow than in *M. c. piute,* the profile of the head with but a very weak subfastigial shallow concavity, this less marked than in *M. c. dumicola;* fastigio-facial angle but slightly sharper (i.e. more subacute) than in the male of *M. c. piute;* basal outline of eyes not as broadly ovate as in *M. c. piute,* but more so than in *M. c. dumicola,* in which form the eye is more elliptical, dorsal and ventral sections of eye outline more subangulate than in *M. c. piute* but more rounded than in *M. c. dumicola.* In cephalic view the frontal costa is narrower than in *M. c. piute,* and in this respect very similar to that of the male of *M. c. dumicola,* the bounding carinae splaying out as much dorsad as in *M. c. piute,* but between the paired ocelli and the antennal bases more closely approaching one another than in the average male of *M. c. piute,* in this respect very similar to *M. c. dumicola;* also in the same view the eyes are appreciably deeper than in *M. c. piute,* and essentially as in *M. c. dumicola.* Antennae with spatulation distad more marked than in the norm of *M. c. dumicola.*

Cerci with distal portion falcate, less strongly decurved than in extremes of the species and not at all "bill-hooked" toward apex.

Cephalic and median limbs slightly more elongate and the femora slightly more attenuate than in *M. c. piute,* essentially as in *M. c. dumicola.* Caudal femora more attenuate than in *M. c. piute,* resembling those of *M. c. dumicola* in this respect.

*Allotype.*—♀; same locality and date as type. [Academy of Natural Sciences of Philadelphia.]

*Description of Allotype.*—Head in profile much as in the same sex of *M. c. dumicola* but the dorsal fastigial and occipital outline is more strongly and evenly arcuate as a whole, while the fastigio-facial angle, in the same view, is moderately acute-angulate, but slightly less so than in *M. c. dumicola;* basal outline of eye broader and shorter than in *M. c. dumicola,* which latter, as in the male sex, has the eye outline narrower and more elliptical.

Ventral ovipositor valves as seen in ventral aspect slightly narrower proximad than in *M. c. dumicola.* Limbs showing the same greater attenuation compared with *M. c. piute* as noted in the description of the male sex.

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[27] The exact position of this collecting station was about 17 miles in an air-line distance ESE. of Fredonia, Arizona, overlooking the Prismatic Plains to the north. Its elevation was about five hundred feet below the plateau rim there, and over two thousand feet above the low point in the Prismatic Plains on the road to Fredonia.

*Morphological variation.*—This subspecies shows much the same range of structural variation which has already been noted in other components of *californica.* Occasionally, as seen in profile, there is a low transverse indentation where the fastigium joins the occiput, also in the male there is some little variation in the degree of constriction of the frontal costa between the interocellar and interantennal sections, although this averages narrower than in *M. c. piute.*

*Size variation.*—The following measurements (in millimeters) of extreme and type individuals from the type locality give the range seen in the series before us.

| | Length of body | Length of antenna | Length of pronotum | Length of cephalic femur | Length of median femur | Length of caudal femur |
|---|---|---|---|---|---|---|
| ♂, *paratype* ..... | 9.4 [28] | 2.3 | 1.8 | 2.6 | 2.5 | 8.3 |
| ♂, *type* ..... | 12.0 | 2.3 | 1.8 | 3.0 | 2.8 | 8.6 |
| ♂, *paratype* ..... | 11.6 | 2.8 | 1.8 | 2.8 | 2.6 | 8.8 |
| ♀, *paratype* ..... | 15.9 | 2.5 | 2.3 | 2.8 | 2.8 | 10.2 |
| ♀, *allotype* ..... | 18.8 | 2.2 | 2.8 | 2.6 | 2.8 | 10.7 |
| ♀, *paratype* ..... | 19.4 | 2.5 | 2.5 | 2.8 | 3.0 | 10.8 |

*Coloration, tone and pattern.*—As a whole the series of females of this subspecies averages as largely fuscous as in *M. c. californica.* The males are not as dark as the females, with more rufescent tendencies on the dorsum, and the dark postocular bars are of variable strength and completeness (well defined in type). The females from the type locality average very dark, particularly on their lateral surfaces, and in all individuals of both sexes the darker transverse caudal femoral bars are indicated to a greater or lesser degree. Two of the four females from 6100 feet elevation on the northern escarpment of the Kaibab Plateau are lighter in tone than any of that sex from 6700 feet. Six of the nineteen females from 6700 feet elevation have a well-marked dorsal longitudinal rufescent or buffy bar, and the same is true of one of the four from 6100 feet elevation. Thirteen of the nineteen females from 6700 feet elevation have well-marked pale

[28] Apex of abdomen much upcurved. Straight line body length would be somewhat greater than this measurement.

maculations ventro-caudad on the lateral lobes of the pronotum, as well as three of the four of that sex from 6100 feet. One female from 6700 feet has both the broad pale dorsal bar and the lateral lobe maculations strongly indicated. The ventral portion of the lateral lobes of the pronotum of all the male individuals is chalky white and contrasted with the general dorsal tone which ranges from dull rufescent to wood brown. No males show a clearly defined pale dorsal bar as seen in some of the females of this and other subspecies of *M. californica*.

*Paratypic series.*—We are designating as paratypes seven males and eighteen females taken at the type locality and in company with the type and allotype, and four females taken at the same locality but at a somewhat lower elevation, i.e. 6100 feet, on the same day.

*Distribution.*—This subspecies as far as known at present occurs only on the northern section of the escarpment of the Kaibab Plateau of north Arizona (see map 1). This uplift is immediately north of the Grand Canyon of the Colorado, but most of its southern and central portion is too elevated and too boreal for *Morsea* and its preferred host plant—*Purshia tridentata*—to occur there. The type locality, which is the only exact one for the subspecies before us, is on the upper section of the relatively lower northern escarpment of the plateau, the surface level of which is there in the neighborhood of 7000 feet, the type locality being slightly lower, at 6700 feet. Large areas of the plateau to the southward lift to 8000 feet or higher (even locally exceeding 9000 feet). These latter areas are boreal or even Hudsonian in their biota, and *Morsea* is probably limited to altitudinally suitable peripheral areas of the plateau. The record of *M. c. dumicola* from Big Springs on the Kaibab Plateau, by Ball, Tinkham, Flock and Vorhies, clearly refers to this subspecies. This locality is about 15 miles SSE. of the type locality in a canyon debouching northward on the Prismatic Plains, and at an elevation of approximately 6500 feet.

*Habitats.*—An overnight camp was made at the type locality, and the first specimen of this subspecies, a female, was "found early in the morning asleep with its head and pronotum tucked between two pebbles on bare ground and [with its hind legs]

partially akimbo. Others were found under 'juniper' [a local Mormon name for *Purshia tridentata*], where, while it was still cool, they were not hard to take, but later became very active—a few beaten from the same bush. It apparently sleeps on the ground, jumping up into the 'juniper' to feed during the day. Later in the day it became infrequent, but was found in small groups in many [*Purshia*] bushes with none under them. Their resemblance to small twigs of the plant was remarkable." At this station *Purshia tridentata* was frequent in a habitat dominated by true juniper (*Juniperus*) and pinyon, with a low cover of rabbit weed (various composites). Lower at 6100 feet elevation on the same escarpment it was also found about *Purshia*, and probably it was there as numerous as at the higher type locality, but time permitted only a limited search.

*Seasonal Appearance.*—The date on which the type series was collected (September 3) and August 30 (the date on the single "Kaibab Plateau" individual) are the only ones we know for this subspecies. Its maturity period is thus probably the same as that of the other subspecies of *M. californica*, but its adult cycle may be shorter, as winter conditions come early on the Kaibab.

*Localities represented:*

ARIZONA: Northwest escarpment slope of Kaibab Plateau, 6700 feet (27), 6100 feet (4), and Kaibab Plateau with no exact locality[29] (1) (Coconino Co.).

**Morsea californica dumicola** Rehn and Hebard Text-figs. 27-30.

*Morsea californica dumicola* Rehn and Hebard, Trans. Amer. Entom. Soc., XLIV, pp. 229, 235, pl. XII, figs. 3, 7, and 13, pl. XIII, fig. 3 (1918) [♂ (type), ♀; Prescott (type locality), near Granite Peak, Mt. Union and Senator, Yavapai County, Arizona].[30]

This subspecies and *M. c. kaibabensis* are very close to one another, and probably represent relatively recent developments from the same line of the species. It is probable that the separation of these forms dates from the barrier produced by the

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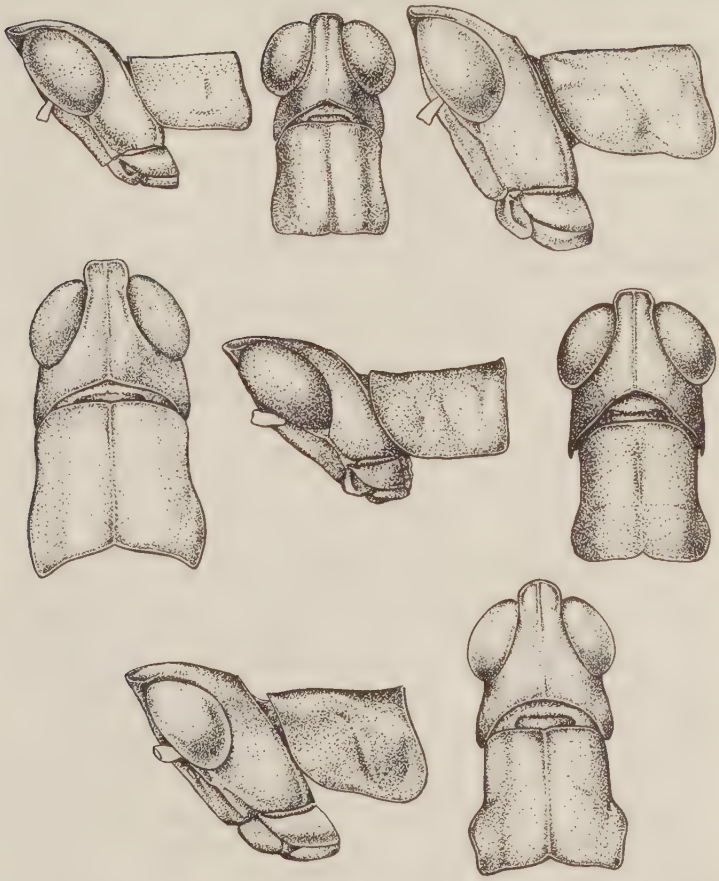
[29] This is probably the "Big Spring" record of Ball, Tinkham, Flock, and Vorhies. The specimen was collected by Ball.

[30] As already shown the Crestline and Caliente, Nevada material referred to *c. dumicola* in 1918 belongs instead to *M. c. piute* here described.



Figs. 23-26.—*Morsea californica kaibabensis* new subsp. Paratypes from Kaibab Plateau, Arizona. Fig. 23 (upper left), lateral view of head and pronotum of ♂ (×7); fig. 24 (upper center), dorsal view of same (×7); fig. 25 (upper right), lateral view of head and pronotum of ♀ (×10); fig. 26 (left of second row), dorsal view of same (×10).

Figs. 27-30.—*Morsea californica dumicola* Rehn and Hebard. Paratypes from Prescott, Arizona. Fig. 27 (center of second row), lateral view of head and pronotum of ♂ (×12); fig. 28 (right of second row), dorsal view of same (×12); fig. 29 (lower left), lateral view of head and pronotum of ♀ (×10); fig. 30 (lower right), dorsal view of same (×10).

cutting of the Grand Canyon of the Colorado.

The type of this subspecies, from Prescott, Arizona, is in the collection of the Academy of Natural Sciences of Philadelphia (Type no. H 481), with the allotype and an extensive paratypic series.

In the original description will be found a review of the features of this subspecies, which, except for the deletion of comments made on the Caliente and Crestline individuals, now known to represent *M. c. piute,* remains of service in understanding this subspecies, other than that *M. c. kaibabensis* was then not known. The features distinguishing *M. c. dumicola* from *M. c. kaibabensis* have been discussed under the latter subspecies. The head structure differences which have been stressed in the key to the forms of the species should serve to distinguish this subspecies from *M. c. piute.*

*Morphological variation.*—It has already been noted that the variation in the degree of angulation of the fastigio-facial angle when seen in profile is much as in *M. c. californica,* although the great majority of the material examined conforms to the type which has already been discussed as typical for *M. c. kaibabensis* and *M. c. dumicola.* The Prescott series alone shows a fair degree of variation in this angle, as already noted. The supposed broader and shorter pronotum, mentioned in 1918 as diagnostic, however, is not supported by the more extensive series now available.

*Coloration, tone and pattern.*—The discussion under this heading given by Rehn and Hebard in 1918 should be consulted as fully relevant, exclusive of the references to Caliente and Crestline individuals which are now known to represent *M. c. piute.* The broader representation now available is otherwise fully covered by the earlier discussion.

*Measurements.*—Rehn and Hebard in 1918[31] gave measurements of material of this subspecies from four localities in central Arizona. These are included in the accompanying table (table 5) together with others drawn from individuals from localities not then available.

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[31] Trans. Amer. Entom. Soc., XLIV, p. 237.

*Distribution.*—From the Coconino Plateau at the south rim of Grand Canyon of the Colorado this subspecies is distributed locally, and where environmentally favorable, southward over the central plateau and mountain area of Arizona, to at least as far as Yarnell, in the southern part of Peeples Valley and close

Measurements (in millimeters) of extremes on representative individuals

| | Length of body | Length of antenna | Length of pronotum | Length of cephalic femur | Length of median femur | Length of caudal femur |
|---|---|---|---|---|---|---|
| M. c. dumicola ♂ | | | | | | |
| Prescott, Arizona, type | 10.2 | 2.3 | 1.6 | 2.4 | 2.3 | 8.1 |
| Prescott, Arizona, paratype | 9.2 | 1.8 | 1.5 | 2.3 | 2.1 | 7.4 |
| Prescott, Arizona, paratype | 11.0 | 2.4 | 1.7 | 2.6 | 2.4 | 8.6 |
| Granite Peak, Arizona | 11.1 | 2.4 | 1.7 | 2.6 | 2.4 | 8.1 |
| Senator, Arizona | 9.7 | 2.3 | 1.5 | 2.6 | 2.2 | 8.1 |
| Senator, Arizona | 10.4 | 2.3 | 1.6 | 2.7 | 2.6 | 8.6 |
| Glenn Oaks, Arizona | 10.5 | 2.0 | 1.8 | 2.6 | 2.3 | 9.0 |
| Glenn Oaks, Arizona | 11.6 | 2.5 | 1.8 | 2.8 | 2.6 | 8.8 |
| Cornville, Arizona | 11.8 | 2.5 | 1.8 | 3.0 | 2.6 | 9.4 |
| Yarnell, Arizona | 9.7* | 2.6 | 2.2 | 3.0 | 3.0 | 9.4 |
| Yarnell, Arizona | 12.3 | 2.3 | 1.8 | 3.0 | 2.6 | 9.6 |
| ♀ | | | | | | |
| Grand Canyon of the Colorado, Arizona | 18.1 | 2.3 | 2.3 | 2.8 | 2.6 | 10.2 |
| Prescott, Arizona, allotype | 17.0 | 1.9 | 2.1 | 2.4 | 2.3 | 10.0 |
| Prescott, Arizona, paratype | 15.0 | 1.8 | 1.9 | --- | 2.3 | 9.3 |
| Prescott, Arizona, paratype | 18.5 | — | 2.2 | 2.6 | 2.8 | 10.0 |
| Granite Peak, Arizona | 17.2 | 1.7 | 2.0 | 2.3 | 2.2 | 10.0 |
| Mount Union, Arizona | 18.5 | 2.0 | 2.1 | 2.6 | 2.6 | 10.0 |
| Glenn Oaks, Arizona | 18.4 | 2.2 | 2.2 | 2.8 | 2.6 | 10.5 |
| Yarnell, Arizona | 15.7* | 2.5 | 2.5 | 2.8 | 2.6 | 12.8 |
| Yarnell, Arizona | 18.9 | 2.0 | 2.6 | 3.0 | 3.0 | 11.8 |

* Abdomen strongly upcurved. Straight line measurement would somewhat exceed this measurement.

Table 5. Size variation in *Morsea californica dumicola.*

to the escarpment forming the Weaver Mountains. It is before us from as low as the Rio Verde Valley at Cornville (see map 1). It is not known to extend into the lower areas of western or southern Arizona, nor east of the southern rim of the Grand Canyon area or the Rio Verde Valley at Cornville.

Altitudinally the lowest point from which it is known is 3300 feet at Cornville, but here it may actually have been taken at a somewhat higher level on the slopes to the northeast which rise regularly from the relatively low bottom-land of the Rio Verde. Yarnell is at an altitude of about 4900 feet, Prescott 5400 feet, and Jerome 5200 feet, although at all these places short distances give considerable additional differences. Ashfork is at approximately 5000 feet, and Mt. Union material conceivably could have come from altitudes ranging between 6500 and 7000 feet. At the south rim of the Grand Canyon it was found at about 7000 feet, which may be as high as the subspecies occurs. Extensive work, over a number of seasons, failed to produce *Morsea* in the Flagstaff area.

In general the zonal distribution of *M. c. dumicola* is Upper Sonoran, entering Transition territory at its higher levels of occurrence.

*Habitats.*—None of the material of *M. c. dumicola* as now understood was personally collected, and few notes on its plant association are available. Notes on Prescott material state that it was taken on thorny bushes,[32] and Ball, Tinkham, Flock, and Vorhies[33] state that it is "most abundant on buckbrush (*Ceanothus* sp.) but is also common on other plants such as cliff rose (*Cowania mexicana*), mountain mahogany (*Cercocarpus*) and sometimes manzanita (*Arctostaphylos*) and other associated shrubs." Just what plant was referred to by the collectors of the Prescott material is not known, but it may have been a mountain mahogany (*Cercocarpus*), which some of the subspecies of *M. californica* are known to frequent.

*Seasonal Appearance.*—The earliest date before us represented by adult material is July 20 (Senator, Arizona), following which dates in late July are represented by similar individuals, through

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[32] See Rehn and Hebard, Trans. Amer. Entom. Soc., XLIV, p. 238 (1918).
[33] Univ. of Ariz., Tech. Bull. no. 93, p. 282 (1942).

August, and to as late as September 4 (Grand Canyon National Park, Arizona) and 27 (Cornville, Arizona). Quite small immature individuals are before us taken as early as June 21, and others representing the instar preceding maturity as late as August 2 (Ashfork, Arizona). Adults and immature individuals were taken together on July 20 and 23 (Senator, Arizona, all adults except two immature females in the instar preceding maturity) and 27 (Yarnell, Arizona, including adults of both sexes and immature females), and August 19 (Glenn Oaks, Arizona, largely adults) and 17 and 24 (Prescott, Arizona, adults of both sexes and immature females).

*Localities represented:*

ARIZONA: South Rim of Grand Canyon, Grand Canyon National Park (Coconino Co.) (1). *Ashfork, 5000 feet (1), Cornville (1), Jerome (1), *Prescott (69), *Mount Union, Prescott (1), *Senator, near Mt. Union, Prescott (9), *Yarnell (9) and Glenn Oaks (24) (Yavapai Co.).

# REEXAMINATION OF SOME NEARCTIC SPECIES OF THE GENUS CALLIBAETIS EATON, WITH THE DESCRIPTION OF A NEW SPECIES (EPHEMEROPTERA; BAETIDAE)

BY

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The genus *Callibaetis* Eaton is confined to the new world and is particularly abundant in the western portions of North America. At the present time twenty-three nearctic species have been described, one of which, *C. hageni* Eaton, has been declared a *nomen dubium* by Edmunds and Allen (1957)—an action with which I am in entire accord. In the remaining forms there are two major problems—the inadequate descriptions of the earlier authors and the lack of good morphological criteria for the species. This paper is an attempt to resolve both of these difficulties in part.

First, redescriptions of two species, *C. doddsi* Traver and *C. fuscus* Dodds, are given. The original descriptions by Dodds (1923) were so nebulous that Traver had to treat these species in a most cursory manner in the systematic section of The Biology of Mayflies (1935). Since that time they have remained one of the major obstacles in the study of the western fauna. I am particularly indebted to Harold J. Grant, Jr. of the Academy of Natural Sciences of Philadelphia for the loan of the types of these two forms.

Secondly, I have tried to deal with the problem of good morphological criteria for some of the species; those previously used have been the coloration and the venation of the forewing. It has been found, however, that these characters are especially prone to wide variation. In my study of the genus I have come to the conclusion that the male genitalia and the venation of the hindwing of both sexes offer good characters for the separation of the species. Consequently, I have figured these structures whenever the identification of a species was certain.

In this study I have utilized not only the material in my own collections (T.B.T.) and the types previously mentioned from the Academy of Natural Sciences of Philadelphia (A.N.S.P.), but also the large collection of the genus from the Illinois Natural History Survey (I.N.H.S.). I would like to thank Dr. H. H. Ross for the loan of the latter specimens.

**Callibaetis doddsi** Traver

*C. vitreus* Dodds 1923, *nec* Navas 1918.
*C. Doddsi* Traver 1935, new name proposed.

This species is closely related to *C. traverae* Upholt, *C. floridanus* Banks, *C. montanus* Eaton, and *C. fluctuans* (Walsh). All have the male forewing unpigmented, few crossveins in the forewing behind vein $R_2$, and, where the females are known, an absence of dark clouds on the longitudinal veins of this sex. The male genitalia, the venation of the hindwing, and the paired marginal intercalaries are distinctive of the species *doddsi*.

The type, a single male (A.N.S.P. Type number 9027) preserved in alcohol, is represented and is in a rather poor state of preservation. The color pattern is still distinct, however. As it was impossible to make slides of the male genitalia and hindwing, these structures were difficult to observe, but they appeared to be well represented by the figures given orginally by Dodds.

*Type locality.*—Tolland, Colorado (July, 1921, G. F. Dodds).

*Measurements.*—Length of body 6.5 mm.; forewing 6.3 mm.; caudal filaments 13.0 mm.

*Head.*—Yellow-tan. Antennal scape and pedicel very light brown; flagellum yellow-white, with small white bulb at base marked with brown. Ocelli white, ringed with black at base. Venter and vestigial mouthparts yellow-white, marked with light brown. Vertex between eyes and frontal shelf dark red-brown.

*Thorax.*—Dark red-brown on dorsum of all segments, broken only by very narrow streaks of white at anterior edge of mesoscutum; mesoscutellum dark, with light anterior and posterior margins. Propleura medium brown; meso- and metapleura light brown, very broad brown band extending from wing base to tip of mesoscutellum and also continued onto the venter. All sternites light brown.

*Wings.*—Forewings without pigment; veins Sc and R tan, others yellowish hyaline; no alteration of light and dark in longitudinal veins; crossveins and wing margin uniformly hyaline; marginal intercalaries occurring in pairs, usually even in length; about 14 crossveins behind vein $R_2$. Hind-

wings without pigment and as in the figure given by Dodds.

*Legs.*—Forecoxae and trochanters light brown, other segments missing. Mid- and hindlegs loose in vial and very similar to one another; femora yellow-tan, tibia and tarsi lighter; tarsal joints narrowly marked with brown distally.

*Abdomen.*—First segment with dorsum uniform dark brown, venter light brown. Tergites of remaining segments medium brown, light narrow median stripe. Venter light brown, submedian and lateral dark oval spots on each side.

*Caudal filaments.*—Only the stubs remain; these are uniform light brown.

**Callibaetis fuscus** Dodds Fig. 1.

*C. fuscus* Dodds 1923.

The original material upon which Dodds based his description consisted of a series of one male, one female, and one nymph. The author (1958) designated the male of this series as lectotype (A.N.S.P. Type no. 9026). In addition, other males and females collected and determined by Dodds, but not included in the type series, are in the collections of the Illinois Natural History Survey. They agree exactly with the type material and have been utilized in the redescription. Fig. 1 is drawn from these specimens. *C. fuscus* is closely related to *Callibaetis evergreenensis* sp. n. (described below) but is separable by the characters cited in the description of the latter.

*Type locality.*—Tolland, Colorado (July, 1915, G. F. Dodds).

***Lectoholotype.***—♂.

*Measurements.*—Length of body 8.0 mm.; forewing 10.0 mm.; caudal filaments 16.0 mm.

*Head.*—Medium brown. Vertex between eyes and frontal shelf dark brown; venter and vestigial mouthparts light brown with dark brown markings. Antennal scape and pedicel dark brown; flagellum missing on type, in other material light brown. Upper facet of compound eye medium brown, lower black. Ocelli white, with black basal ring.

*Thorax.*—Pronotum dark brown, areas immediately lateral to median line lighter; propleura and venter light brown, heavily stippled with fine brown dots; meso- and metapleura and venters similar. Mesonotum dark brown with two submedian and one median cream stripes anteriorly, fading in middle of segment; posterior uniform black-brown with narrow light stripe leading onto and including tip. Metanotum dark brown margined in black.

*Wings.*—Longitudinal veins alternately dark and light in the anterior region, uniformly brown in posterior; crossveins yellow-hyaline, about 37

behind vein $R_2$; marginal intercalaries paired, anterior vein longer than posterior one; wing margin uniformly yellow-brown. Vitta extending to radius; continuous basal two-thirds, with 13 roundish hyaline areas; larger hyaline area in the upper two cells; distally and beneath with few more small hyaline cells. Hindwings pigmented with brown proximally; venation as in figure presented by Dodds.

*Legs.*—All legs light brown, tibiae yellowish and margined in dark brown; tarsal joints narrowly margined with brown distally.

*Abdomen.*—Light brown, stippled with fine dark brown dots. Tergites with lighter median area and lateral light spot on each side. Sternites with median light stripe, margined on each side by dark stripe, lateral areas lighter. Each segment, dorsum and venter, finely margined with dark brown on posterior.

*Genitalia.*—Yellow-white, as in fig. 1.

*Caudal filaments.*—Uniformly light brown.

*Lectoallotype.*— ♀.

As in the male, but with lighter coloration and the following exceptions.

Compound eyes black. Mesonotum not margined with black on posterior; venter of thorax lighter cream color. Abdomen medium brown, very dense, uniform, and dark stippling; very small lateral light spots on tergites. Wing margin alternately dark and light. Light stigmatic dots on abdomen.

*Nymph* (not reared).

This specimen is in very poor condition and, as a result, little can be added to the original description except for the following items.

Wing pads black, indicating specimen was ready to emerge. Caudal filaments uniformly pale, not banded with black. Femur without apical band. No distinctive markings visible on the abdomen.

Other specimens identifiable as this species have been taken at the following locality.

Colorado: Beaver ponds, Kokomo, 9,000 ft. July 23, 1938. H. H. and J. A. Ross, collectors (many ♂♂ and ♀♀, I.N.H.S. and T.B.T.).

**Callibaetis evergreenensis** sp. nov. Figs. 2-3.

This species is separable from all of the nearctic species of *Callibaetis*, except *C. coloradensis* Banks, *C. nigritus* Banks, and *C. fuscus* Dodds, by the absence of dark clouds around the veins in the disc of the forewing of the female, and the presence of pigment and the alternately dark and light coloration of the longi-

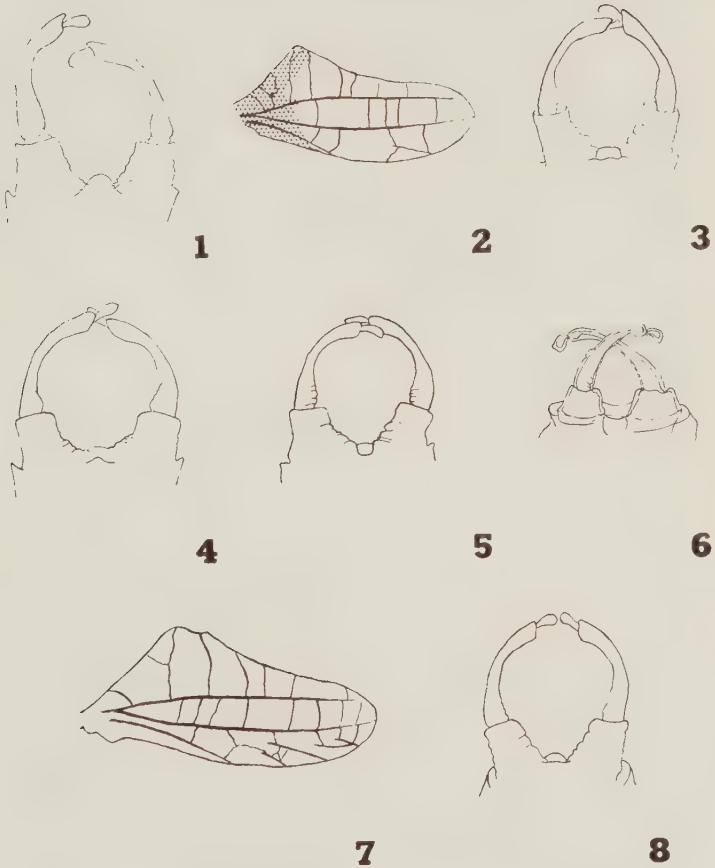


Fig. 1, male genitalia of *Callibaetis fuscus* Dodds; Fig. 2, hindwing of *C. evergreenensis* sp. nov.; Fig. 3, male genitalia of *C. evergreenensis* sp. nov.; Fig. 4, the same of *C. ferrugineus* (Walsh); Fig. 5, the same of *C. fluctuans* (Walsh); Fig. 6, the same of the subimago of *C. montanus* Eaton; Fig. 7, hindwing of *C. pretiosus* Banks; Fig. 8, male genitalia of *C. pretiosus* Banks. All figures greatly enlarged.

tudinal veins of the forewing of the male. It can be distinguished from *coloradensis* by the brown pigment present in the basal costal space of the female and also by the venation of the hindwing; from *nigritus,* by the light brown (not black) thorax and vitta, and the abdominal maculation; from *fuscus,* to which it is most closely related, by the male genitalia, the venation of the hindwing, and the coloration of the thoracic notum of the female.

*Holotype.*—♂ ; Evergreen, Jefferson County, Colorado; Aug. 24, 1956 (A. L. Baily; specimen in alcohol) [Academy of Natural Sciences of Philadelphia, Type no. 9363].

*Measurements.*—Length of body 6.5 mm.; forewing 6.5 mm.; caudal filaments 16.3 mm.

*Head.*—Black-brown. Vertex between compound eyes black-brown; frontal shelf same but with two submedian yellow spots; face brown, vestigial mouthparts white; genae brown, marked with yellowish white ventrally; venter of head white. Antennal scape dark brown, pedicel and flagellum white. Turbinate portion of compound eyes light brown, lower portion black. Ocelli white, ringed with black at base.

*Thorax.*—Pronotum dark red-brown, median cream colored streak and two posterior, submedian cream colored dots on each side; pleura lighter red-brown, marked with cream, this merging into white prosternum, having basisternum set off anteriorly and posteriorly with dark brown sutures. Mesoscutum dark brown anteriorly, fading to light brown posteriorly, with light tan median stripe running entire length; anterior edges of scutum plus prescutum cream; scutellum brown with wide white median stripe; postscutellum deep brown, cream tip; mesopleura cream, broadly stippled and marked with light brown; mesosternum uniformly light brown, except for basisternum, which is cream mottled with dark brown, and around the coxae, where it is light tan. Metanotum brown with blackish brown posterior margin; metapleura cream, heavily marked with brown; metasternum cream, mottled with dark brown dots.

*Wings.*—Forewing with longitudinal veins alternately light and dark; crossveins white, about 30-40 behind vein $R_2$; marginal intercalaries paired, those placed anteriorly longer than the posterior ones; wing margin uniformly light brown. Vitta light brown; more or less continuous in the costal space, except hyaline basal costal space and about 12-14 hyaline spots around crossveins; vitta broken into four distinct lobes in subcostal and radial interspaces—one basal, two median, and one apical—all widely separated. Hindwings (fig. 2) with relatively numerous crossveins; longitudinal and crossveins pale brown proximally, hyaline distally; light brown pigmentation in basal and costal areas of wing.

*Legs.*—Forecoxae and trochanters white, with dark brown sutures, stippled with very fine brown dots; forefemora yellow with a few brown dots and

two fine black lines on each edge. Foretibiae and tarsi uniformly light brown, distal ends of tarsal segments margined with black. Mid- and hind-legs yellowish white; coxae, trochanters, and femora marked as in foreleg, but with heavier stippling; tibiae yellow-white, lateral edges finely margined in black, stippled with very fine brown dots, with distinct dark brown ring proximally; first tarsal joint yellow-white proximally, grey distally; remainder dark grey.

*Abdomen.*—Cream colored, densely mottled with brown dots; dots on tergites more dense than on sternites. Tergites with median cream colored stripe, which is bisected on posterior segments by narrow brown stripe, all tergites bordered on each side by a wide brown band; apical segments with distinct, less densely mottled spots becoming diffuse posteriorly; last tergite uniform light brown, lighter median stripe and two light submedian dots. Sternites with two submedian stripes, somewhat indistinct posteriorly; stippling concentrated into narrow band at posterior of each segment; segments 1-9 with apicolateral dark brown spot on each side; last sternite with only two submedian dark brown spots.

*Genitalia.*—Forceps light brown proximally, fading to white distally. Penis lobes as in fig. 3.

*Caudal filaments.*—Pale brown, narrowly and lightly marked with dark brown at joints.

*Allotype.*— ♀ ; same data as holotype. [Academy of Natural Sciences of Philadelphia.]

*Measurements.*—Length of body 6.2 mm.; forewing 7.0 mm.; caudal filaments 10.0 mm.

*Head.*—Cream colored, with dark brown markings; vertex between eyes and frontal shelf cream, two submedian dark brown stripes, stippled with brown dots which are especially heavy medially but extremely fine around the compound eyes and ocelli; two white dashes anterio-medially; face, vestigial mouthparts, genae and venter of head all cream colored, sutures dark brown, with fine dark brown stippling. Antennal scape white proximally with narrow black ring distally; pedicel white proximally, black distally. Compound eyes white distally, blackish shading proximally.

*Thorax.*—Pronotum with cream colored median stripe, flanked on each side by a very wide brown band, with anterior submedian white spot; remainder cream with dark brown dots; pleura cream stippled with dark brown, large dark brown spot medio-laterally; prosternum cream colored, sutures broadly marked in dark brown; posterior edges and tip of scutum cream; prescutum white; postscutum brown, tip and posterior edges broadly white; mesopleura cream, with heavy brown stippling, sutures broadly marked with dark brown; mesosternum cream, with heavy dark brown stippling, except pleurotrochantin which is uniformly cream. Metanotum deep brown, posterior margins black; metapleura and sternum cream, with heavy dark brown dots and sutures.

*Wings.*—As in the male, except for the following: vitta black-brown; forewing margin alternately light and dark; basal costal space whitish hyaline proximally, brown distally. Pigmentation in basal area of hindwing more extensive than in male.

*Legs.*—All similar, as follows: coxae and trochanters cream colored, with dark brown stippling and sutures; femora light tan, lightly stippled with brown, with two faint black lines on each edge; tibiae white, with narrow dark ring apically; tarsi white, distal end of each joint tinged with black.

*Abdomen.*—Cream colored, heavily stippled with dark black-brown. Tergites with median, less densely stippled stripe; lateral margins heavily stippled, thereby making a long streak of dark brown. Sternites uniformly stippled with dark brown, with only a narrow median and two extreme lateral dark stripes.

*Caudal filaments.*—White, joints narrowly margined with brown; every other segment margined with dark brown, others with light brown.

*Paratypes.*—3 ♂♂, 5 ♀♀; same data as holotype; 1 ♂, 2 ♀♀ in the collections of the Academy of Natural Sciences of Philadelphia, and 2 ♂♂, 3 ♀♀ in the collection of the author.

*Variation in the male paratypes.*—Length of body 6.0-6.3 mm.; forewing 5.5-6.0 mm.; caudal filaments 10.0-11.5 mm. (broken). Compound eyes of one specimen more yellow-tan than brown; coloration of thorax constant, except for the median stripe on mesoscutum, which may be of heavier or lighter intensity; forelegs more yellowish and mid- and hindlegs more whitish than in holotype; vitta of forewing more reduced in two specimens, having the proximal half of the costal space hyaline, except for a few dark brown spots.

*Variation in the female paratypes.*—Length of body 6.0-7.5 mm.; forewing 6.0-8.0 mm. Thorax often lighter than in allotype, being a uniform light tan, with the median dark area almost obscured. Abdomen sometimes lighter on the venter than on the dorsum.

In addition, there are eight subimagos, none of which were designated as types, in the collection of the author. I have also seen specimens in the Illinois Natural History Survey collections which are referable to this species. They were not included in the type series because of slight color variations. These specimens were taken at the following locality.

WYOMING: L. Slide Lake, Gros Ventre Mts., Moose. Aug. 11, 1940. T. H. Frison and T. H. Frison, Jr., collectors (many ♂♂ and ♀♀, I.N.H.S.).

**Callibaetis brevicostatus** Daggy

*C. brevicostatus* Daggy 1945.

Burks (1953) reported this species from Saskatchewan (no other data), the only locality other than the type locality in Minnesota from which it is known. I have examined the specimen, a single male, and am convinced that it represents this species. The full data are SASKATCHEWAN, Indian Head, Aug. 18, 1947 (I.N.H.S.).

**Callibaetis ferrugineus** (Walsh) Fig. 4.

*Cloe ferruginea* Walsh 1862.

An excellent redescription of this species, as well as figures of the fore- and hindwings, was given by Burks in 1953. I am presenting a drawing of the male genitalia (fig. 4) of specimens from Lake Geneva, Wisconsin. On the basis of the different configurations of this structure in the species *ferrugineus* and *skokianus*, I cannot agree with Burks that they might be synonymous. They appear to be distinct and easily separable.

I have examined specimens of this species from the following localities. (The Minnesota specimens represent a new state record.)

MICHIGAN: Paw Paw. Aug. 19, 1940. At light. Lucy M. Ayars, collector (many ♂♂ and ♀♀, I.N.H.S.); Sept. 11, 1950. James S. Ayars, collector (4 ♂♂, I.N.H.S.).

MINNESOTA: Willmar. July, 1941. James H. Mohr and W. P. Mohr, collectors (3 ♂♂, I.N.H.S.).

WISCONSIN: Lake Geneva. June 5, 1938. H. H. Ross and B. D. Burks, collectors (many ♂♂ and ♀♀, I.N.H.S. and T.B.T.); Mukwonagan. June 5, 1938. H. H. Ross and B. D. Burks, collectors (many ♂♂ and ♀♀, I.N.H.S.).

**Callibaetis fluctuans** (Walsh) Fig. 5.

*Cloe fluctuans* Walsh 1862.

This species was redescribed by Burks (1953) and figures of the wings were presented. I am giving a figure of the male genitalia (fig. 5) from a topotypical specimen from Moline, Illinois, in my personal collection. The following specimens represent a new state record.

KANSAS: Junction City. July 29, 1938. H. H. Ross, collector (many ♂♂ and ♀♀, I.N.H.S.).

**Callibaetis montanus** Eaton Fig. 6.

*C. montanus* Eaton 1883-1888.

This species is known from Central America, Mexico, and southwestern United States. The original description by Eaton (1883-1888) gave figures of the wings. Spieth (1941) presented additional notes on the type series. Fig. 6 shows the subimagal male genitalia and is taken from the following specimens.

TEXAS: Hidalgo. Nov. 29, 1945. R. H. Beamer, collector (many ♂♂ and ♀♀, I.N.H.S. and T.B.T.).

**Callibaetis pretiosus** Banks Figs. 7-8.

*C. pretiosus* Banks 1914.

I am holding under this name specimens which agree quite well with the incomplete description of the species given by Banks. Berner (1950) reported a variant of this species from Florida, the only state from which it is known other than its type locality in Virginia. The main variation of the specimens cited below lies in size. In the female type, the length of the forewing is about 6.5 mm., while in the northern form it is often from 7.5-9.0 mm. The latter may well represent another subspecies. As the male has never been fully described, I am taking this opportunity to present the following notes based on a specimen from Paw Paw, Michigan.

*Measurements.*—Length of body 8.0 mm.; forewing 6.5 mm.; caudal filaments 12.0 mm.

*Head.*—White; face marked with dusky yellow. Antennae white, scape shaded with grey distally. Turbinate portion of compound eyes yellow-white, lower portion black. Ocelli white, ringed with black at base.

*Thorax.*—Dusky yellow; tip of mesonotum shaded with grey; metanotum yellow-grey. Sternites and pleura yellowish white, sutures lightly shaded with brownish yellow.

*Legs.*—Yellow-white; forelegs missing; mid- and hindfemora lightly shaded with brown distally; tarsi narrowly marked with brown on distal margin of each segment.

*Wings.*—Forewing hyaline, without pigmentation or vitta; stigmatic area milky-white; longitudinal veins yellowish hyaline, crossveins whitish hyaline; about 40 crossveins behind vein $R_2$; marginal intercalaries double anteriorly, single posteriorly. Hindwing hyaline, as in fig. 7.

*Abdomen.*—Yellow-white. Tergites finely stippled with light brown; median area lighter, bordered on each side with darker stripe, light spot on each side of these, somewhat anterior; segments 8-10 darker yellow. Ster-

nites with a pair of median brown streaks on each segment. All segments with grey-black stigmatic dots.

*Genitalia.*—Yellow-white, as in fig. 8.

*Caudal filaments.*—White, joints narrowly and faintly marked with grey.

The specimens cited below represent new state records.

CONNECTICUT: Mt. Carmel. Sept. 27, 1943. Sweeping dry grass. Katherine Sommerman, collector (1 ♀, I.N.H.S.).

MICHIGAN: north fork of Au Sable River, near Lorell. May 24, 1936. Justin W. Leonard, collector (1 ♀, I.N.H.S.); Paw Paw. July 12, 1950. At light. Lucy and James Ayars, collectors (4 ♀♀ and 1 ♂, I.N.H.S. and 1 ♀, T.B.T.).

MINNESOTA: Basswood Lake, Winton. Aug. 19, 1941. At light. T. H. Frison, collector (1 ♀, I.N.H.S.); Ely. Aug. 20, 1940. W. D. Balduf, collector (1 ♀, 1 ♀ subimago, I.N.H.S.); Lake Hubert. Aug. 11, 1941. At light. H. H. Braucher, collector (1 ♀, I.N.H.S.).

ONTARIO: Sinicoe Lake, Swansea. Sept. 1, 1937. H. S. Parish, collector (1 ♀, I.N.H.S.).

WISCONSIN: Totogatio River, Minong. Sept. 3, 1939. B. D. Burks, collector (1 ♀, I.N.H.S.).

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# A REVIEW OF THE GENERA PSYCHOMASTAX AND EUMORSEA (ORTHOPTERA; ACRIDOIDEA; EUMASTACIDAE)

BY

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The present analysis is the eleventh collateral paper[1] which has been required by the continued preparation of the monograph of the Orthoptera of North America, being sponsored by the National Science Foundation. Previous work on the genus *Psychomastax* has necessitated a complete reanalysis of all available material containing, as the latter does, all that on which earlier work was based. This resurvey and broadened study has much increased our knowledge of the elements of the genus and their distribution, and also brought to light differential features not previously known. New records and a new species of *Eumorsea* are given in the following brief review of that genus.

The material used in the present paper totals 238 specimens of *Psychomastax,* of which 147 are in the collection of the Academy of Natural Sciences of Philadelphia, including the types of all the forms recognized, 87 from that of the Museum of Zoology of the University of Michigan, three from the Los Angeles County Museum, and one from the Museum of Comparative Zoology. Of the genus *Eumorsea,* 25 specimens have been available, these belonging to the University of Arizona (13), Academy of Natural Sciences of Philadelphia (9), and the California Academy of Sciences (3). To the authorities of the above mentioned institutions we wish to extend our sincere thanks for their cordial cooperation.

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[1] The first eight titles of this series have been given in footnote 1 on page 13 of this volume of these Transactions. The ninth was "The Phallic Complex in the Subfamilies of New World Eumastacidae and the Family Tanaoceridae," in the 1958 volume of the Proceedings of the Academy of Natural Sciences of Philadelphia, and the tenth "A Revision of the Genus Morsea (Orthoptera; Acridoidea; Eumastacidae)," which comprised pages 217-259 of the present volume.

## PSYCHOMASTAX Rehn and Hebard

1918. *Psychomastax* Rehn and Hebard, Trans. Amer. Entom. Soc., XLIV, pp. 225, 242.

Type of genus (by original designation).—*Psychomastax psylla* Rehn and Hebard.

This genus with *Morsea* Scudder and *Eumorsea* Hebard constitute the subfamily Morseinae, erected by Rehn in 1948.[2] Its generic features were presented and discussed when it was originally described, and then comparisons were made with the allied genus *Morsea*. In 1934 Hebard published a more comprehensive study of *Psychomastax*[3] in which he added two additional forms which he regarded as subspecies of the type species *psylla*, and also placed on record much geographic and bionomic information which had been acquired in field work over the years between 1918 and 1933. Unfortunately this study gave some erroneous associations of material, which, with the latter before us, we have corrected in the present resumé. In 1942 Rehn and Rehn[4] presented a key to a number of the genera of New World Eumastacidae, in which the differences of *Psychomastax* from *Eumorsea* and *Morsea* were summarized.

It has been possible for us to study the phallic structure of the male sex of four of the entities here considered. Unfortunately, in one, which in other respects is well marked, the male sex at present is not known. The results of our study of all the available material demonstrates that the genus has three distinct specific lines, each with wellmarked ectophallic characters, as well as reasonably distinctive external features. These three lines center about the species *psylla, robusta* Hebard and *deserticola* Hebard, which latter two that author regarded as subspecies of *psylla*. Of these, the *psylla* line is more distinct ectophallically from the other two than they are from one another. The *psylla* line comprises two subspecies, typical *p. psylla* of the San Jacinto and San Bernardino Mountains of southern California, and *p.*

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[2] Proc. Acad. Nat. Sci. Phila., C, pp. 108, 114.
[3] Trans. Amer. Entom. Soc., LIX, pp. 363-370, pl. XXII, figs. 1-6.
[4] Proc. Acad. Nat. Sci. Phila., XCIV, pp. 4-5.

*inyo*, here described, from the Inyo-White range in Inyo County, California. The *robusta* line contains a single entity which, however, has a definitely disjunct distribution as explained beyond. The *deserticola* line is made up of two subspecies, one *P. d. deserticola* of the Mojave Desert and adjacent desert areas on the northern side of the San Bernardino range, and *P. d. indigena*, here described, known only from the vicinity of Belted Peak in southeastern Nevada.

Of the previous records given by Hebard in the above-cited study, attention should be called to the following errors in the association of material. Under *P. p. psylla* he reported a female from above Round Valley, Inyo County, California, which proves to be a teneral female of *Morsea californica piute* Rehn and Grant, recently described. Under *P. psylla robusta* his record of that form from the west base of Belted Peak, Nevada, proves to be quite different, and is the basis of *P. deserticola indigena* here described. Also the individuals from Silver Canyon Trail and from near Goat Spring, in the White Mountains, California, represent the here-described *P. psylla inyo*, and the specimen from upper Wild Rose Canyon in the Panamint Mountains, California, represents the same line and is discussed beyond in more detail.

*Internal genitalia of the male of Psychomastax* (see figs. 1-8, and for *P. psylla psylla*, Rehn and Grant, Proc. Acad. Nat. Sci. Phila., CX, Plate 26, Figs. 10-13, 1958).—Ectophallus largely membranous to moderately sclerotized. Ectophallic membrane forming, on dorso-lateral surfaces, an elongate, weakly curved, dorsally rounded structure which terminates caudad in a well sclerotized pigmented boss which is set with sensillae-like processes. Ectophallic valves prominent, only moderately sclerotized distad, with simple apices or laterally extended in decurved lamellate structures. Dorsal fold simple or complexly folded. Dorsal surface of ectophallus weakly to strongly concave. Ventral fold simple. Epiphallus of the bridge type, moderately sclerotized, with uncinate lophi, which are apically blunt or bearing a weak laterad-directed tooth.

From the phallic structures alone it is evident the species of this genus fall into three clearly defined elements. However, in this respect these specific units form but two evolutionary lines. One line is represented by the species *psylla*. In an evolutionary sense it appears to be on the same plane, i.e. neither more or less

specialized, as the other line. It is, however, clearly separable by the following characters: distal ends of ectophallic valves not extending laterad, " boomerang "-shaped as seen from above and not projecting much, if at all, above the dorsal surface of the ectophallus; dorsal fold simple; epiphallus with triangulately thickened lophi (as seen in caudal aspect). The second line is represented by the species *robusta* and *deserticola,* which are very closely related. They differ from *psylla* in the shape of the ectophallic valves, which possess, laterally, an overhanging lamellation, which appears rounded or elongate from the dorsum, in having the ectophallic valves projecting well above the dorsal surface of the ectophallus, in having a relatively complex dorsal fold and thinner epiphallic lophi. The two species of this line may be distinguished from one another genitalically by rather subtle differences in the form of the distal portion of the ectophallic valves (see figures 1-3 and 5-7).

*Discussion.*—It seems, from the present study, that the three specific elements of *Psychomastax* have had a relative antiquity, and this most particularly in the case of the *psylla* stock on one hand, and the *robusta* and *deserticola* ones on the other. In addition to the complex of morphological features, the present pattern of distribution, and our accompanying knowledge of the bionomics of the elements, suggest that *psylla* is probably the older stock, perhaps more broadly spread in pre-Pleistocene times, and that *P. p. inyo* represents a relict element of the species. The species *robusta* may have had a distributional optimum in Pleistocene times, as it is clearly more partial to more heavily

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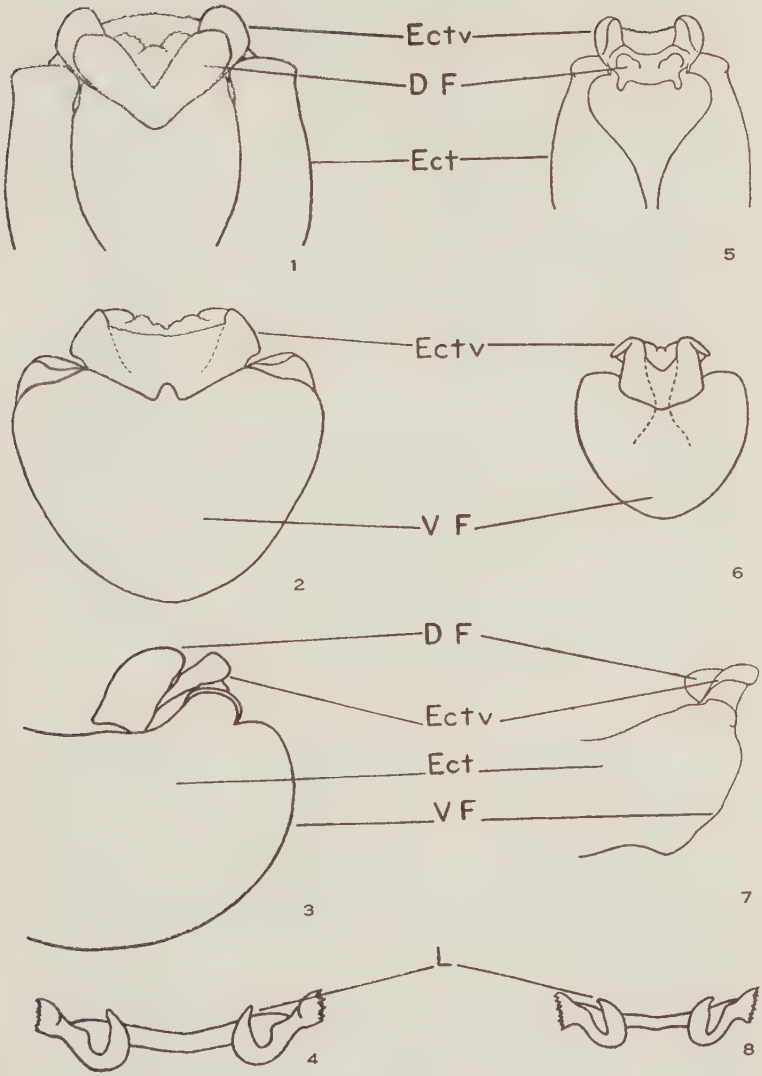
Figs. 1-8. Phallic complex of species of *Psychomastax.* Figs. 1-4, *Psychomastax robusta* (*paratype,* Charleston Peak, Nevada). Fig. 1, apex of phallic complex, dorsal view; Fig. 2, the same, posterior view; Fig. 3, the same, left lateral view; Fig. 4, epiphallus, posterio-dorsal view. Figs. 5-8, *Psychomastax deserticola deserticola* (*paratype,* Cushenbury Ranch, California). Fig. 5, apex of phallic complex, dorsal view; Fig. 6, the same, posterior view; Fig. 7, the same, left lateral view; Fig. 8, epiphallus, postero-dorsal view. (Abbreviations: DF = dorsal fold of ectophallus; Ect = ectophallus; Ectv = ectophallic valves; L = lophi of epiphallus; VF = ventral fold of ectophallus.)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timbered and cooler regions than the other forms of the genus, and today has a disconnected distribution, as detailed on a following page, separated by areas from which the genus is not at present known, the stations of the present occurrence of *robusta* ranging in altitude from about 6000 to over 11,000 feet. The *deserticola* element, on the other hand, is of warmer, definitely more desert environments than *robusta* or *psylla,* and as ectophalically it is less removed from *robusta* than from *psylla,* it is probably more recent, yet its specific distinctness from *robusta* is clearly affirmed by its eternal morphology.

*Intra-specific variation.*—In *Psychomastax* we find there is a very marked amount of individual variation in the relative length and robustness of the proximal (metatarsal) and distal articles of the caudal tarsi, even in individuals from the same immediate locality. Twenty females of *P. robusta,* all paratypes, from Charleston Peak and adjacent lower slopes of the Charleston Mountains, Nevada, taken at elevations ranging from 8000 to at least 10,200 feet, show a marked range in the total length of the caudal tarsus and of its proximal (metatarsal) and distal components. Measurements in gratings, made with 10× oculars and a 2.0 objective, give the following relative proportions:

| | Total of caudal tarsus (from base of arolium to proximal tarsal articulation) | Length of caudal metatarsus (from evident base of disto-dorsal margin) | Length of caudal distal tarsal article |
|---|---|---|---|
| 8600 feet | 69 | 35 (50%) | 21 (30%) |
| 8600 feet | 73 | 38 (52%) | 22 (30%) |
| 8500 feet | 73 | 38 (52%) | 23 (31%) |
| 8000-8500 feet | 80 | 44 (55%) | 25 (31%) |
| 8000-8500 feet | 76 | 43 (56%) | 22 (29%) |
| 8000-8500 feet | 78 | 41 (52%) | 25 (32%) |
| 8000-8500 feet | 79 | 43 (54%) | 24 (30%) |
| 8900-9600 feet | 85 | 45 (53%) | 25 (29%) |
| 9000-11,400 feet | 75 | 37 (50%) | 26 (34%) |
| 10,000 feet | 75 | 35 (46%) | 25 (33%) |
| 10,200 feet | 71 | 33 (46%) | 22 (31%) |
| 10,200 feet | 72 | 36 (50%) | 24 (33%) |
| 10,200 feet | 74 | 37 (50%) | 25 (33%) |
| 10,200 feet | 71 | 36 (49%) | 24 (32%) |
| 10,200 feet | 68 | 33 (48%) | 23 (33%) |
| 10,200 feet | 65 | 34 (52%) | 18 (27%) |
| 10,200 feet | 74 | 37 (50%) | 24 (32%) |
| 10,200 feet | 70 | 35 (54%) | 23 (32%) |
| 10,200 feet | 75 | 39 (52%) | 23 (30%) |
| 10,200 feet | 71 | 39 (55%) | 22 (34%) |
| Extremes | 65-85 | 33-45 (46-56%) | 18-26 (27-34%) |

(Percentages shown are of total length of caudal tarsus)

It is evident from the above that the ratio range in percentages of the length of the metatarsus and of the distal article to the total caudal tarsal length is considerable. Futher, there is no correlation of segments of this proportional range with specific elevations, and personal knowledge of the senior author, who collected parts of this material, of localized conditions of the Charleston Mountains evidences there also is no population correlation, and the range shown is one of purely individual variation.

The ventro-external margin of the ventral ovipositor valves of the female in *Psychomastax* similarly shows marked variation in individuals of that sex from the same immediate locality. The armament of this margin ranges from three or so relatively

large and well-spaced spiniform teeth to a more numerous series of low denticles of serrate character. The extremes noted appear most distinctive, but the available larger series show a broad range of connecting degrees of development.

*Distribution of the Genus.*—From the lower levels of the eastern Ventura Mountains, California, on the Kern-Ventura Counties line, southward at least as far as Coahuila, Riverside County, eastward in the San Jacinto and San Bernardino Mountains, and into the Mojave Desert along the north base of the latter range, and to the northward reaching the eastern slopes of the more southern Sierra Nevadas, the White-Inyo range across Owen's Valley, the western slope of the Panamint Mountains west of Death Valley, the Charleston Mountains in Clark Co., Nevada, with the northeastern known point at the west base of Belted Peak in Nye Co., Nevada. Altitudinally the genus is known to reach as high as 11,500 feet on the summit of Charleston Peak, but the components of the genus would seem to have definite preferences in their altitudinal ranges, which are here discussed individually. Zonally the forms of the genus range from Lower Sonoran to as high as Hudsonian, the latter in the Sierras, the Charleston Mountains, and the White Mountains. The genus is not as yet known from Baja California, but in all probability will be found there in the San Pedro Martir Mountain section.

Map 1. Distribution of the genus *Psychomastax*. Open circle = *P. psylla psylla;* circle with top filled = intermediate between *P. psylla psylla* and *P. psylla inyo;* circle with bottom half filled = *P. psylla inyo;* filled circle = *P. robusta;* circle with right half filled = *P. deserticola deserticola;* circle with left half filled = *P. deserticola indigena.*

## Key to the Forms of Psychomastax

(Based chiefly on female external characters, and male ectophallic structures for the specific entities.)

1. Caudal femora more robust, 5.2 times or less as long as deep. Median and cephalic limbs shorter and more robust proportionately ..... 4

Caudal femora more slender, 6 times or more as long as deep. Median and cephalic limbs longer, more slender ..... 2

2. Frontal costa of female more uniform and subequal in breadth from the paired ocelli ventrad. Head as a whole narrower in the female. (San Jacinto and San Bernardino Mountains (except Cactus Flat), California).
*P. psylla psylla* Rehn and Hebard

Frontal costa of female of varying width ventrad of the paired ocelli. Head as a whole broader in the female ..... 3

3. Antennae shorter in both sexes. Cephalic and median limbs somewhat shorter. Sclerotized lateral portions of the subgenital plate of the male strongly narrowing to their apices dorso-mesad. Phallus of male as in *P. p. psylla*. (Inyo-White Mountains, Inyo Co., California).
*P. psylla inyo* new subspecies

Antennae longer in both sexes. Cephalic and median limbs somewhat longer. Sclerotized lateral portions of the subgenital plate of the male broader at their lateral bases and less markedly narrowing to their apices dorso-mesad. Phallus of male as in figs. 1-4. (Eastern side of southern Sierra Nevada range, California, and Charleston Mountains, Nevada).
*P. robusta* Hebard

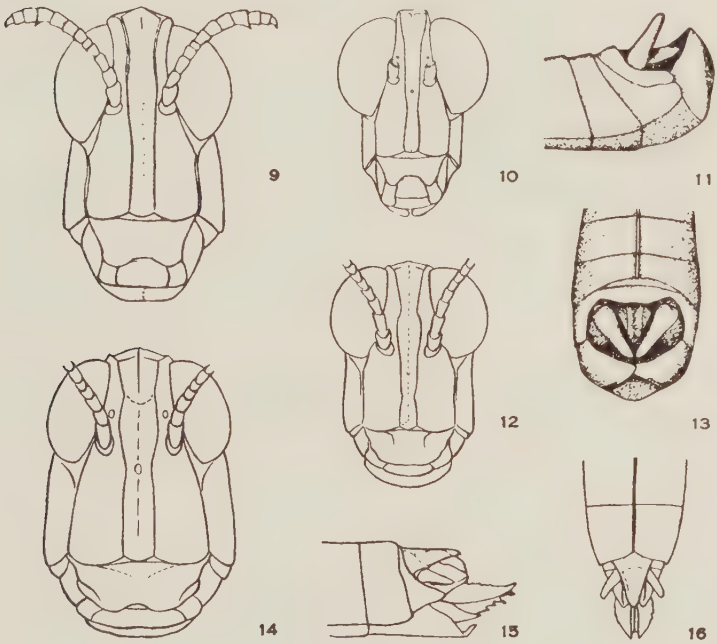
4. Size smaller (body length, ♀, 11.3-14.3 mm.). Head in both sexes relatively narrow, in female somewhat narrower across the genae than across the eyes. Frontal costa at fastigio-facial juncture distinctly narrower than twice as broad as at the constriction ventrad of the median ocellus. Eyes more prominent in cephalic aspect. Phallus of male as in figs. 5-8. (Mojave Desert and certain adjacent areas of the San Bernardino Mountains, California.) ..... *P. deserticola deserticola* Hebard

Size larger (body length, ♀, 25.2 mm.). Head in female (only sex known) quite broad, subequal in breadth across the genae to that across the eyes. Frontal costa at fastigio-facial juncture more than twice as broad as at the constriction ventrad of the median ocellus. Eyes less prominent in cephalic aspect. (Belted Range, Nye Co., Nevada.)
*P. deserticola indigena* new subspecies

**Psychomastax psylla** Rehn and Hebard Figs. 9-11, 13, and 15-16.

This species is composed of two subspecies occupying distinct areas in California. The typical subspecies occupies a reasonably cohesive area, chiefly in the San Jacinto and San Bernardino

Mountains and their general vicinity, except as modified by the intrusion of Lower Sonoran Mojavan influence at Cactus Flat on the northern slope of the San Bernardino range. The other subspecies, which is closely related but well separable, is known only from several relatively high level stations in the Inyo-White Mountains. Intergradation between the two is represented by a single female from the Panamint Mountains here discussed.




Figs. 9-16. Morphological aspects of *Psychomastax*. Fig. 9. *P. psylla psylla*, ♀, *allotype*, San Jacinto Mtns., California, head, cephalic aspect; Fig. 10, *P. psylla psylla*, ♂, *type*, San Jacinto Mtns., California, head, cephalic aspect; Fig. 11, *P. psylla psylla*, ♂, *type*, apex of abdomen, left lateral aspect; Fig. 12, *P. robusta*, ♂, *paratype*, Lee Canyon, Nevada, head, cephalic aspect; Fig. 13, *P. psylla psylla*, ♂, *type*, apex of abdomen, dorsal aspect; Fig. 14, *P. robusta*, ♀, *paratype*, Lee Canyon, Nevada, head, cephalic aspect; Fig. 15, *P. psylla psylla*, ♀, *allotype*, apex of abdomen, left lateral aspect; Fig. 16, *P. psylla psylla*, ♀, *allotype*, apex of abdomen from above.

**Psychomastax psylla psylla** Rehn and Hebard Figs. 9-11, 13, 15, and 16.

*Psychomastax psylla* Rehn and Hebard, Trans. Amer. Entom. Soc., XLIV, p. 243, pl. XI, fig. 1, pl. XII, figs. 1, 5, 9, 11, 15, 17, and 19, pl. XIII, figs. 1, 5, 7, and 9 (1918) [♂ (*type*), ♀; Strawberry Valley, San Jacinto Mountains, Riverside Co., California (type locality); Coahuila, Riverside Co., California].[5]

*Psychomastax psylla psylla* Hebard, Trans. Amer. Entom. Soc., LIX, pp. 364, 365, pl. XXII, figs. 1 and 2 (1934) [additional localities, Cuddy Canyon, Ventura Mountains, and Vivian Creek, San Bernardino Mountains, California].

It is now clearly evident that *P. psylla* represents a very distinct specific line from either *P. robusta* or *P. deserticola,* as is clearly demonstrated by their ectophallic characters alone.

The original description details the chief morphological characteristics of this species, as well as an analysis of its color tones and pattern.

*Internal genitalia of male.*—The phallic complex of *P. psylla* has already been described and figured elsewhere by us (Proc. Acad. Nat. Sci. Phila. CX, pp. 307-308, Plate 26, figs. 10-13 (1958)).

*Size range.*—As Hebard added no measurements to the few originally presented of the few then known, we are giving a series of extremes drawn from the considerable series now before us.

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[5] As already stated, Hebard's 1934 record of *psylla* from above Round Valley, Inyo Co., California, is based not on a *Psychomastax* but on a teneral individual of *Morsea californica piute* Rehn and Grant, which is now before us.

*Measurements (in millimeters) of representative individuals*

| | Length of body | Length of antenna | Length of pronotum | Length of cephalic femur | Length of median femur | Length of caudal femur |
|---|---|---|---|---|---|---|
| ♂ | | | | | | |
| Strawberry Valley, Cal., type | 10.8 | 2.4 | 1.8 | 2.6 | 2.7 | 8.0 |
| Strawberry Valley, Cal., paratype | 9.6 | 2.0 | 1.7 | 2.4 | 2.3 | 7.9 |
| Victorville, Cal. | 12.7 | 2.1 | 1.6 | 2.3 | 2.1 | 6.9 |
| NE. slope of San Bernardino Mts., Cal. | 8.3 | 1.9 | 1.3 | 1.8 | 1.8 | 5.6 |
| NE. slope of San Bernardino Mts., Cal. | 9.5 | 1.9 | 1.5 | 1.9 | 1.9 | 6.1 |
| ♀ | | | | | | |
| Cuddy Canyon, Ventura Mts., Cal. | 18.3 | --- | 2.3 | 2.6 | 2.6 | 8.6 |
| Strawberry Valley, Cal., allotype | 17.2 | 2.0 | 2.5 | 2.8 | 2.8 | 9.5 |
| Strawberry Valley, Cal., paratype | 16.0 | 1.9 | 2.3 | 2.6 | 2.6 | 8.5 |
| Strawberry Valley, Cal., paratype | 18.0 | 2.0 | 2.6 | 2.7 | 2.8 | 9.6 |
| Coahuila, Cal., paratype | 18.1 | 2.0 | 2.5 | 2.7 | 2.7 | 9.9 |
| NE. slope of San Bernardino Mts., Cal., 4750 feet | 10.7* | 1.7 | 2.2 | 2.2 | 2.2 | 8.2 |
| NE. slope of San Bernardino Mts., Cal., 4750 feet | 14.9 | 1.6 | 2.0 | 2.0 | 2.0 | 6.9 |
| Vivian Creek, San Bernardino Mts., Cal. | 15.3 | 1.8 | 2.5 | 2.8 | 2.8 | 9.7 |
| Vivian Creek, San Bernardino Mts., Cal | 17.3 | 2.0 | 2.6 | 3.0 | 3.0 | 9.9 |

* Body somewhat upcurved

This above table makes clear that in *P. psylla* there is marked size variation, both areally and individually. The small size of the individuals from the northeast slope of the San Bernardino Mountains may be due to the depauperating effect of semi-desert conditions on the species, but apparently this is not reflected in the single Victorville male.

*Distribution.*—From the lower slopes of Cuddy Canyon in the Ventura Mountains southward as far as Coahuila, Riverside County, California, and eastward in the San Jacinto and San

Bernardino Mountains. While the genus had not been reported, nor is it now available, from the San Gabriel Range, it probably occurs in that area.[6] The single specimen before us labelled as from Victorville, San Bernardino Co., may have been taken on one of the lower mountains a few miles north of Victorville (which reach as high as 4500 feet) or on the Sidewinder or Granite Mountains ten or so miles to the east, and which reach as high as 5100 feet (see map 1). Altitudinally the typical form of the species is now known to range from as low as 3800 feet, at Cajon Pass, and 3600 feet at Coahuila, to as high as 7200-7800 feet along Vivian Creek,[7] and 8300 feet on Butler Peak Outlook Road, in the San Bernardino range. Zonally it is Upper Sonoran and Transition in its range. The specimen intermediate between *P. p. psylla* and *P. p. inyo,* from upper Wild Rose Canyon in the Panamint range is discussed under Remarks.

*Habitats.*—The usual locale is brush cover under juniper and pinyon, or under taller and more truly forest cover. At the type locality it was taken infrequently in a spiny chaparral area on a steep slope surrounded by pine forest. At Vivian Creek it was moderately numerous in forest of sugar pine (*Pinus lambertiana*), incense cedar (*Libocedrum decurrens*), and Douglas fir (*Pseudotsuga taxifolia*) about patches of a low gray-green leaved spiny bush. At four miles east of Running Springs, in the same mountains, it was swept from manzanita (*Arctostaphylos* sp.) in pine and fir forest, in an area where manzanita, chinquapin (*Castanopsis* sp.) and other bushes formed low dense mats. On Mill Creek, in the same range, it was taken at 6000 feet elevation by Dr. Timberlake on incense cedar (*Libocedrum decurrens*). In Cuddy Canyon in the Ventura range it was found very scarce in antelope brush (*Purshia tridentata*) growing in a wash. In upper Wild Rose Canyon, in the Panamint range, it was in sage brush in the open juniper and pinyon zone.

*Seasonal Appearance.*—Immature individuals and adults were

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[6] One of the original specimens on which Scudder based the species *Morsea californica* from Cajon (Cahon) Pass, between the San Bernardino and San Gabriel ranges, is now before us, and proves to be *Psychomastax psylla.*

[7] See Hebard, Trans. Amer. Entom. Soc., LIX, p. 365 (1934).

taken together on July 29 on the northeast slope of the San Bernardino Mountains, and at the west end of Baldwin Lake higher up in the same range, while an adult is before us taken at Cajon Pass on July 19. Other adults represent the following dates: August 1 (Victorville), 18 (Coahuila), 22 (four miles E. of Running Springs, San Bernardino Mts.), 27 (Strawberry Valley, San Jacinto Mts.), September 6 (Upper Wild Rose Canyon, Panamint Mts.), and October 26 (Butler Peak Outlook Road, San Bernardino Mts.).

*Remarks.*—A single female specimen [8] from 7300 feet elevation in upper Wild Rose Canyon, on the west side of the Panamint range in Inyo County, California,[9] is clearly intermediate between typical *psylla* and *p. inyo* here described. In its general head shape and in the basal outline of the eye, it more closely approaches *P. p. inyo,* but the pronotal outline and the longer caudal tarsi more resemble those of *P. p. psylla.* This probably indicates that the *P. psylla* line was more broadly distributed in the recent past, perhaps in the colder and more humid phases of the Pleistocene. The inference is justified that the *psylla* line was formerly more broadly distributed to the northward of the San Bernardino Mountains, and that today it is essentially a relict in the semi-arid White-Inyo range.

*Localities represented:* [10]

### Typical *P. p. psylla*

CALIFORNIA: Cajon Pass (1), Victorville (1), Mill Creek, San Bernardino Mts., 6000 feet (1), 4 ms. E. of Running Springs, San Bernardino Mts., 6700 feet (2), Butler Peak Outlook Road, San Bernardino Mts., 8300 feet (3), northeast (desert) slope of San Bernardino Mts., 4750 and 5750 feet (85), and W. end of Baldwin Lake, San Bernardino Mts., 7000 feet (2) (San Bernardino Co.).

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[8] Reported by Hebard in 1934 as *P. psylla robusta* (Trans. Amer. Entom. Soc., LIX, p. 368).

[9] This is the immediate area known as "Charcoal Kilns," given in the list of localities visited by the Death Valley Expedition of 1891 (North American Fauna no. 7, p. 365 (1893)). It was a base for Rehn and Hebard in August, 1922.

[10] These are supplementary to those given by Hebard in 1934 (Trans. Amer. Entom. Soc., LIX, p. 368) except where here corrected.

Intermediate between *P. p. psylla* and *P. p. inyo*

CALIFORNIA: Upper Wild Rose Canyon, Panamint Range, 7300 feet (Inyo Co.) (1).

**Psychomastax psylla inyo**[11] new subspecies Figs. 17 and 21.

*Psychomastax psylla robusta* Hebard, Trans. Amer. Entom. Soc., LIX, p. 365 (1934). (In part only.) [Solely the records from Goat Spring and Silver Canyon Trail, White Mountains, California].

This is a more northern, and probably relict, representative of the *psylla* line. The internal genitalia of the male have been found on dissection to agree fully with that of typical *psylla*, and thus the relationship of this subspecies is clearly established. In the preceding key to the forms of the genus, and below, the external differential features are presented.

*Type.*— ♂, Near Goat Spring, White Mountains, Inyo County, California. Elevation, 10,743 feet. September 10, 1919. (Rehn and Hebard.) [Academy of Natural Sciences of Philadelphia, Type no. 5811.]

Agreeing with *P. p. psylla* in most respects, but differing in the somewhat broader pronotum, proportionately broader head ventrad of the eyes, somewhat broader frontal costa ventrad of the paired ocelli, and the somewhat shorter antennae with articles averaging more transverse. The subgenital plate has its sclerotized lateral portions dorso-mesad as characteristically acuminate as in *P. p. psylla*. Cephalic and median limbs slightly shorter than in the same sex of *P. p. psylla*.

*Allotype.*— ♀; Silver Canyon Trail, White Mountains, Inyo County, California. Elevation, 9,500 feet. September 10, 1919. (Rehn and Hebard.) [Academy of Natural Sciences of Philadelphia.]

Agreeing with the original female material of *P. p. psylla* in most respects, but differing, as does the male, in its broader head as seen in cephalic aspect, with its depth ventrad of the median ocellus proportionately less than in *P. p. psylla*, and in the frontal costa being somewhat broader, particularly ventrad of the constriction immediately dorsad of the paired ocelli. Cephalic and median limbs slightly shorter than in the same sex of *P. p. psylla*.

*Internal genitalia of male.*—The phallic complex of a paratypic male indicates that it cannot be separated specifically from *P. p. psylla*.

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[11] After the Inyo range, of which the White Mountains of California form the more northern part.

*Coloration.*—This subspecies apparently has no noteworthy color differences from *P. p. psylla*, the few available specimens showing the same range in tone and pattern as in the typical form of the species.

*Measurements.*—Hebard in 1934 [12] gave the dimensions of the specimens here considered.

*Distribution.*—This subspecies is known only from two localities at upper levels on the west slope of the White Mountain section of the White-Inyo range bordering Owen's Valley on the east, in eastern California. Near Goat Spring it was taken at 10,743 feet, and along Silver Canyon Trail (which, higher, passed near Goat Spring) it was taken at 9500 feet (see Map 1). The upper of these localities was in essentially Hudsonian Zone conditions, the lower at the Boreal-Transition boundary. The individual intermediate between *P. p. psylla* and *P. p. inyo* from the Panamint Mountains was taken at approximately the lower borders of the Transition Zone.

*Habitats.*—Near Goat Springs it was beaten from wild gooseberry (*Ribes* sp.) bushes on an almost bare slope of shaly debris among bristle-coned pines (*Pinus aristata*), and lower along the Sliver Canyon Trail it was found on the ground among a few similar bushes at the upper border of the juniper and pinyon belt. No typical Boreal forest belt is present in this range, and sage extends virtually to the timber-line.

*Seasonal Appearance.*—All the known typical material of this subspecies was taken adult on September 10, that from the Panamint range on September 6.

*Material examined.*[13]

California: Near Goat Spring, White Mts., Inyo Co., 10,743 feet; IX, 10, 1919; (R. and H.) 1 ♂ (*type*) [A.N.S.P.]. Silver Canyon Trail, White Mts., Inyo Co., 9500 feet; IX, 10, 1919; (R. and H.); 1 ♂ (*paratype*), 1 ♀ (*allotype*) [A.N.S.P.].

**Psychomastax robusta** Hebard Fig. 12.

*Psychomastax psylla robusta* Hebard, Trans. Amer. Entom. Soc., LIX, pp. 364, 365, pl. XXII, figs. 3 and 4 (1934). (In part only.) [♂ (*type*), ♀;

[12] Under *P. p. psylla* (Trans. Amer. Entom. Soc., LIX, p. 367).

[13] All regarded by Hebard in 1934 as *P. psylla robusta* (Trans. Amer. Entom. Soc., LIX, p. 369).

Charleston Peak (type locality) and Lee Canyon, Spring (or Charleston) Mountains, Nevada; upper meadows, Whitney Pass trail, High Sierras, and Lone Pine Canyon, Sierra Nevada, Inyo Co., California].

All the original material used by Hebard when he created this form (then as a subspecies of *psylla*) is now before us. The specimen so referred from near Belted Peak, Nevada, as shown elsewhere in this paper, is *P. deserticola indigena* new subspecies; that from upper Wild Rose Canyon, Panamint Range California, is here shown to be an intermediate between *P. p. psylla* and *P. p. inyo,* and those from two localities in the White-Inyo Mountains, California, represent *P. psylla inyo* here described. The preceding key to the forms of the genus will enable one to recognize this well-marked species with little difficulty.

*Internal genitalia of male* (from a Charleston Peak, Nevada, paratype).—Ectophallus largely membranous, only moderately sclerotized as noted below. Dorsal fold of ectophallic membrane prominent, covering dorsal bases of ectophallic valves, projected dorsad fully as high as the dorsal surface of the ectophallic valves, rather complexly folded (note figs. 1-3). Dorsad the ectophallic membrane is deeply concave, and moderately sclerotized mesad, being flanked laterad by prominent, curved rolls of tissue which are arcuate in section and which terminate, caudad, in well sclerotized and pigmented bosses thickly set with minute, sensillae-like processes (see fig. 1); in lateral aspect the dorsal surface is seen to project laterad, with the ectal (free) border decurved (fig. 3). Ventral fold prominent, covering the ventral bases of the ectophallic valves.

Epiphallus of the bridge type, moderately sclerotized. Lophi simple, uncinate, rather strongly sclerotized, thickened in distal half before the blunt apex; apices directed laterad (fig. 4). Caudo-laterad the disk of the epiphallus extends beyond the bridge on either side as a slightly expanded sclerotized area (fig. 4); disk continuous with surrounding membrane.

*Coloration Notes and Measurements.*—In the original description of *robusta* Hebard presented data bearing on these features, to which nothing can be added at this time.

*Distribution.*—Eastern slopes of the southern Sierra Nevada Mountains of California below Mt. Whitney, with definite altitudinal information from as low as 8000-8300 feet (Lone Pine Canyon [14]) to as high as the upper meadows on Whitney Pass

[14] A specimen, not personally collected, labelled "Lone Pine" is before us. We feel certain it must have been taken in Lone Pine Canyon, and definitely higher than the elevation of the town of Lone Pine, which is virtually on the floor of Owen's Valley.

trail at 10,700 feet, and the Charleston (or Spring) Mountains of Clark Co., Nevada, and there from as low as 6000 (in Lee Canyon) to the summit of Charleston Peak at 11,500 feet. Immature individuals of this genus which may represent this species are before us taken at Walker Pass, Sierra Nevada Mountains, Kern Co., California, from an elevation of 5500 feet, and from upper Kyle Canyon, immediately below Charleston Peak, at 7250 feet, Charleston Range, Clark Co., Nevada (see Map 1).

*Habitats.*—This species has been taken from juniper about six feet from the ground at the lower portion of the juniper and pinyon at 6000 feet in Lee Canyon, Charleston Mountains, from pinyon and wild gooseberry bushes and other mountain plants under bristle-cone pine (*Pinus aristata*) virtually at the summit of Charleston Peak (11,400-11,500 feet). In Lone Pine Canyon in the southern Sierras it was scarce at 8000-8300 feet on almost bare slopes between bushes of mountain mahogany (*Cercocarpus ledifolius*) with bull pine in the canyon and juniper and pinyon above on the slopes. Higher in the upper meadows along the Whitney Pass trail at 10,700 feet it was found on bare white decomposed granite gravel and on granite boulders at the upper edge of the belt of fox-tailed pine (*Pinus balfouriana*). The immature individual taken at 5500 feet on the slopes immediately above Walker Pass, southern Sierra Nevadas, which may represent this species, was beaten from mountain mahogany, which was associated with sage and various "rabbit weed" composites, and the similar immature individual taken at 7250 feet in Kyle Canyon, Charleston Mountains, Nevada, was beaten from low cover in a rocky wash under a tree cover of bull pine (*Pinus ponderosa*), another species of pine and aspen (*Populus tremuloides*).

It is evident that the range of *P. robusta* zonally extends from the lower border of the Transition Life Zone upward to areas which are pronouncedly Hudsonian (as 10,700 feet on the Whitney Pass trail). The latter point is about six hundred feet below the definite timber-line.

*Seasonal Appearance.*—The very small immature individuals now before us, which probably represent this species, were taken May 28 and June 1. An adult female, labelled "Lone Pine Cal,"

was taken July 27 by the late R. H. Beamer. The other material available, all adult, was taken on dates extending from August (August 1-20) in the Charleston Mountains, Nevada, to as late as September 8 (Lone Pine Canyon) in the Sierra Nevadas of California.

*Material examined.*[15]

CALIFORNIA: Lone Pine (Inyo Co.) (1). Walker Pass, Sierra Nevada, 5500 feet (Kern Co.) (1).[16]

NEVADA: Kyle Canyon, immediately below Charleston Peak, 7250 feet, Charleston Mts. (Clark Co.) (1).[16]

**Psychomastax deserticola** Hebard

This species is composed of two subspecies, associated on account of their general similarity in a number of respects, although intergradation is not definitely known, and no material of this specific line is available from the territory intervening between the present known ranges of the two components. The typical subspecies (*d. deserticola*) is known only from a locality at the north (Mojave Desert) base of the San Bernardino Mountains, and another higher, but definitely desert, area on the north side of the same mountains. The other subspecies (*d. indigena*), of which only the female is known, occurs in the vicinity of Belted Peak, Nye Co., Nevada.

**Psychomastax deserticola deserticola** Hebard Figs. 18 and 22.

*Psychomastax psylla deserticola* Hebard, Trans. Amer. Entom. Soc., LIX, pp. 364, 368, pl. XXII, figs. 5 and 6 (1934). [♂ (*type*), ♀; Cushenbury Ranch, lower slopes of San Bernardino Mountains (type locality) and Cactus Flat, San Bernardino Co., California.]

The specific character of *deserticola* is clearly established by the ectophallic features of the male as here described and figured. The external morphological characters are equally distinctive, and have been utilized in the preceding key to the forms of the genus.

*Internal genitalia of male* (from a Cushenbury Ranch paratype).—Ectophallus almost entirely membranous, weakly sclerotized only as noted here. Dorsal fold of ectophallic membrane relatively simple, not com-

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[15] This is supplementary to records already published by Hebard in 1934 (vide supra).

[16] Immature material and specific identity not fully established.

plexly folded, not projecting as far dorsad as the dorsal surface of the ectophallic valves, covering dorsal bases of ectophallic valves (figs. 5-7). Dorsad the ectophallic membrane is very weakly concave mesad, with the sides of the concavity moderately sclerotized, laterad the ectophallic membrane surrounding the concavity is raised on either side as a low, rounded fold of tissue, which terminates caudad in a moderately sclerotized boss, this thickly set with minute, sensillae-like processes. Ectophallic valves prominent, rising dorsad of the dorsal surface of the ectophallus, as seen from dorsum with smoothly rounded lateral margins, which do not extend appreciably laterad, well separated mesad, in lateral aspect the dorsal surface is seen to extend but little laterad and is but weakly, if at all, decurved (fig. 7). Ventral fold prominent, covering ventral bases of ectophallic valves.

Epiphallus of bridge type, weakly to moderately sclerotized. Lophi uncinate, well sclerotized, with distal half before the apex appreciably thickened, apices directed laterad, each with a minute, blunted tooth (fig. 8); caudo-laterad the bridge extends on either side as a weakly expanded, moderately sclerotized portion of the disk (fig. 8); disk continuous with surrounding membrane.

*Colorational features and size.*—Hebard has fully analyzed these in the original discussion. The only additional comment we would make is that the single additional individual now available, that from Cactus Flat taken in 1951, is much deeper, more umber, than any of the others of the considerable original series now before us. In this respect it conforms more to the norm of coloration of *psylla* and *robusta*. It is possible that changed conditions at Cactus Flat between 1919 and 1951 may have been a factor in this respect. At some time during that period the original tree yucca cover of Cactus Flat was largely destroyed by fire, and in 1951 blackened prostrate yucca trunks or their remains had largely replaced the splendid stand of that curious plant which we saw there on the earlier visit. The single specimen taken in 1951 was all seen of this insect, which was far more numerous there in 1919.

*Distribution.*—This subspecies is at present known only from Cushenbury Ranch on the north base of the San Bernardino Mountains, California, at the mouth of Cushenbury Canyon at 4100 feet elevation, and at Cactus Flat, a small, rather level shoulder higher up the same canyon at 5850-5900 feet (see Map 1). Both localities are Lower Sonoran in their life, as has been

shown by Grinnell in his study of the biota of the San Bernardino Mountains.[17]

*Habitats.*—As Hebard stated in 1934 *d. deserticola* occurs in arid environments, and all material now available was taken in chamise (*Adenostoma fasciculatum*). At Cushenbury Ranch (or Springs) there were few such bushes, but this form was found frequently in them. At Cactus Flat, where the so-called "cactus" is the Joshua Tree or tree yucca (*Yucca arborescens*), in an area encircled by juniper and pinyon, it was equally numerous in the chamise then (in 1919) interspersed among the tree yucca. In 1951 plant cover on Cactus Flat had largely been destroyed, but the single specimen then taken was also in chamise.

*Seasonal Appearance.*—The only dates we have for *P. d. deserticola* are of adults taken in the latter part of August (22 and 31).

**Psychomastax deserticola indigena**[18] new subspecies Fig. 19.

*Psychomastax psylla robusta* Hebard, Trans. Amer. Entom. Soc., LIX, p. 365 (1934). (In part only.) [Solely the Belted Peak, Nevada, record.]

This very distinctive subspecies is known only from the single female reported by Hebard (vide supra), which the present study shows is a member of the *deserticola* specific line. The male characteristics are not known, but the affinity of the subspecies, on external morphological grounds, is definitely with typical *deserticola*.

*Type.*—♀; West base of Belted Peak, Nye Co., Nevada.[19] Elevation, 6700 feet. August 25, 1924. (Rehn and Hebard.) [Academy of Natural Sciences of Philadelphia, Type no. 5812.]

Agreeing with *P. d. deserticola* in the proportionately shorter and more robust caudal femora and the shorter and more robust cephalic and median

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[17] Univ. of Calif. Publ. Zool., V, no. 1, pp. 20-22, plates 1 and 2 (1908). Both localities are shown on the U.S.G.S. map of the San Gorgonio quadrangle.

[18] I.e. *native* or *indigenous*.

[19] The exact environment, and in fact the host juniper in which the type was taken, is shown in the lower panel of the plate facing page 60 of the 1924 Yearbook of the Academy of Natural Sciences of Philadelphia. This illustration accompanies a popular account of 1924 Nevada Orthoptera field work.

limbs, the general type of the frontal costa, and the even arcuation of the occipital profile, as well as that of the face, but differing from the same sex of the typical form of the species in the following more noteworthy respects.

Size distinctly larger (length of body, 25.2 mm.). Fastigio-facial angle, as seen in profile, as obtuse as in *P. d. deserticola;* head in cephalic aspect distinctly broader, particularly across the genae, the greatest breadth there subequal to that across the eyes, instead of distinctly less as in *P. d. deserticola,* lateral borders of genae as seen in cephalic aspect appreciably diverging ventrad from the eyes to the mandibular bases, instead of subparallel as in *P. d. deserticola;* frontal costa very broad at the fastigio-facial angle, there more than twice as broad as at the infra-median constriction, lateral borders moderately converging thence ventrad to briefly dorsad of the paired ocelli, thence subparallel to slightly dorsad of the median ocellus, there appreciably constricted and after slightly diverging thence subparallel, and less strongly marked to the supra-clypeal suture, the sulcation of the costa moderately pronounced; lateral facial carinae well marked, slightly diverging ventrad. Eyes in cephalic aspect but moderately prominent, less so than the same sex of *P. d. deserticola,* basal outline of eye as seen in profile not quite as broad as in the latter, dorsal point of outline slightly more narrowly rounded. Antennae damaged. Pronotum slightly longer proportionately than in *P. d. deserticola,* as seen in profile with greatest depth of lateral lobes from dorsal line of pronotum somewhat less than the dorsal length of the pronotum (as 48 to 55), as against subequal in proportions in the same sex of *P. d. deserticola.* Cephalic and median limbs of much the same relative proportions as in *P. d. deserticola,* hence definitely shorter and more robust than in the other species of the genus; caudal femora of the same general build as in *P. d. deserticola,* their greatest depth contained 5.1 times in the greatest length (as 36 to 186); caudal tarsi slightly longer proportionately than in the female of *P. d. deserticola* (compared with the caudal femoral depth as 9 to 5, as against 6 to 4 in the female sex of the typical form of the species).

*Measurements of type.*[20]—Length of body, 25.2 mm.; length of pronotum, 3.0; length of caudal femur, 10.7.

*Coloration.*—General base tone ochraceous-buff with a weak greenish cast, mottled with cloudings, bars or blotches of hair brown to fuscous, these being cloudings across the frontal costa between the antennal bases, another across the face between the

[20] Hebard's measurements (see his 1934 paper) for this specimen are not exact. The above are micrometer measurements made with 10X oculars and a .66 objective. His measurement of the femoral length (9.2) is definitely less than that of the ventral margin of the femur, which is given above.

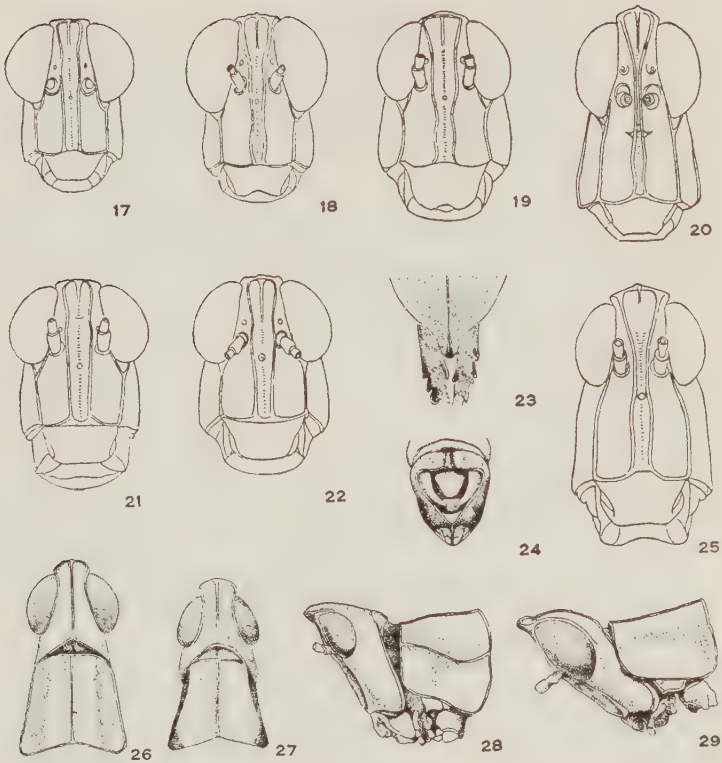
lateral carinae briefly ventrad of the median ocellus, and ventrad a median cloud in the frontal costa, blotches laterad on the pronotal lobes and the other thoracic nota, and cloudings laterad on the abdominal tergites; the cephalic and median limbs have usually weak cloud annuli on all their parts, while the caudal femur (one limb is lacking) has three complete or incomplete dark annuli and the distal extremity is also darkened, the caudal tibia has numerous dark cloud blotches and the spines are infumate distad. Eyes buckthorn brown mottled with fuscous. Two proximal antennal articles (all remaining) are marked with fuscous.

*Distribution.*—The type locality (see Map 1) is the only one from which this subspecies is known, and there, on August 25, 1924, it was taken at night resting on the foliage of a juniper five feet from the ground. The locality, at 6700 feet, is in the juniper and pinyon zone, and hence Upper Sonoran.

*Remarks.*—It would appear to us that *P. d. indigena* indicates that the *deserticola* stock is more widely distributed than available records show, or that *deserticola* was in the recent past more widely distributed, and that two segments of the species have been separated and differentiated. Although a considerable amount of field work has been done in the lower desert areas of southern Nevada and adjacent California north of the San Bernardino Mountains and east of Victorville, no representatives of the genus *Psychomastax* are available from this broad area, outside of the mountain districts where the *robusta* and *psylla* specific elements occur.

*Material examined.*

NEVADA: West base of Belted Peak, Nye Co., elev. 6700 feet; VIII, 25, 1924, (R. and H.) 1 ♀ (*type*); [A.N.S.P.].




Figs. 17-29. Morphological aspects of *Psychomastax* and *Eumorsea*. Figs. 17-22, cephalic aspect of head. Fig. 17, *P. psylla inyo*, ♂, *paratype*, White Mtns., California; Fig. 18, *P. deserticola deserticola*, ♂, *paratype*, Cushenbury Ranch, California; Fig. 19, *P. deserticola indigena*, ♀, *type*, Belted Peak, Nevada; Fig. 20, *E. pinaleno*, ♂, *type*, Mount Graham, Arizona; Fig. 21, *P. psylla inyo*, ♀, *allotype*, White Mtns., California; Fig. 22, *P. deserticola deserticola*, ♀, *paratype*, Cushenbury Ranch, California; Figs. 23-29, *Eumorsea pinaleno*, ♂, *type* and ♀ *allotype* (Graham Mtns., Arizona). Fig. 23, subgenital plate, ♀, ventral aspect; Fig. 24, apex of abdomen, ♂, dorsal aspect; Fig. 25, head, ♀, cephalic aspect; Fig. 26, head and pronotum, ♂, dorsal aspect; Fig. 27, the same ♀; Fig. 28, head and pronotum ♀, left lateral aspect; Fig. 29, the same ♂.

## EUMORSEA Hebard

1935. *Eumorsea* Hebard, Trans. Amer. Entom. Soc., LXI, pp. 119-121.

Type of genus (by monotypy).—*Eumorsea balli* Hebard.

Since its description by Hebard in 1935 our knowledge of this interesting and rare genus of eumastacids has not been expanded.[21] While reviewing all of the available material (including the original series) three new records of *E. balli* and a new species of the genus have come to light. Generic characters and comparisons with the allied genera *Psychomastax* and *Morsea* were given in the original description.

*Internal genitalia of the male of Eumorsea.*—We have already described and figured the male internal genitalia of *E. balli.*[22] Unfortunately, the new species of the genus (described below) is known from a single pair of adults and we do not consider it wise to dissect the male in view of the scarcity of specimens.

*Intra-specific variation.*—The small series available shows very little individual variation. The fastigio-facial angle varies slightly, but in *E. balli* never becomes acute enough to cause confusion in separating that species from *E. pinaleno.* Variation in size for *E. balli* is given by Hebard[23] and for *E. pinaleno,* in the description which follows.

*Distribution of the genus.*—*Eumorsea* is known from the Huachuca, Pinaleno and Santa Rita Mountains of southeastern Arizona, and from Glen Oaks near Prescott in the central part of the state.

### Key to the Species of Eumorsea

1. Apex of caudal femora bearing a minute medio-dorsal tooth; fastigio-facial angle rectangulate or but very slightly acute, the fastigium projecting only a little before the eyes; fastigium with lateral margins subparallel when seen from above; caudal femora of ♂ more robust, about 6.6 times as long as wide; male cerci shorter in relation to basal width, only about twice as long as wide ..... *Eumorsea balli* Hebard

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[21] A single additional record (Santa Rita Mts., Arizona) was published by Ball, Tinkham, Flock, and Vorhies in the Grasshoppers and other Orthoptera of Arizona, University of Arizona, Agricultural Exp. Sta., Technical Bull. 93 (1942).

[22] Proc. Acad. Nat. Sci. Phila., CX, p. 307, figs. 7-9 (1958).

[23] Trans. Amer. Entom. Soc., LXI, p. 121 (1935).

Apex of caudal femora unarmed; fastigio-facial angle distinctly acute, the fastigium projecting well cephalad of the eyes (see figs. 28 and 29); fastigium laterally expanded when viewed from above (see figs. 26 and 27); caudal femora of ♂ markedly elongate, about 8.4 times as long as wide; male cerci longer in relation to basal width, about 2.5 times as long as wide (see fig. 24) ..... *Eumorsea pinaleno* new species

**Eumorsea balli** Hebard

*Eumorsea balli* Hebard, Trans. Amer. Entom. Soc., XLI, pp. 119, 121, pl. IV, figs. 8-11 (1935). (In part.) [♂ (*type*), ♀; Ramsey Canyon above the box, Huachuca Mts., Cochise Co., Arizona (type locality); Carr Canyon, Huachuca Mts., Cochise Co., Arizona; excluding Mount Graham, Pinaleno Mts., Graham Co., Arizona.]

The original description presents in detail the morphological characteristics of this species to which we can add nothing further at this time. The internal genitalia of the male has recently been described and figured by Rehn and Grant.[24] Of the original material, the male record from Mount Graham represents a new species which is described on a following page.

*Distribution.*—This species is known from three well separated mountain areas in central and southern Arizona. In the east it occurs in the Huachucas, being known from three canyons (Ramsey, Carr, and Miller) at altitudes of between 5,000 and 6,000 feet. Further northwest, the species occurs in the Santa Rita Mountains, there having been captured at an altitude of 9,000 feet. In central Arizona, it is before us from Glenn Oaks, near Prescott, but the altitude at which the specimen was captured is unknown.

*Remarks.*—No additional information regarding seasonal appearance or habitats is available. The species is known to occur on the Mexican Pinyon pine (*Pinus cembroides*) and also on "low weeds, herbs, and bushes at some distance from pines."[25]

*Localities represented:*[26]

ARIZONA: Glenn Oaks (Yavapai Co.) (1). Miller Canyon, Huachuca Mts., 6,000 ft. (1), Huachuca Mts., 5,000 ft. (1) (Cochise Co.).

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[24] Proc. Acad. Nat. Sci. Phila., CX, p. 307, figs. 7-9 (1958).

[25] Ball, Tinkham, Flock, and Vorhies, "Grasshoppers and other Orthoptera of Arizona," University of Arizona, Agricultural Experiment Station, Technical Bulletin 93 (1942).

[26] These are supplementary to Hebard, Trans. Amer. Entom. Soc., LXI, p. 121 (1935) and Ball, et al. (see footnote 25 above).

**Eumorsea pinaleno**[27] new species Figs. 20, 23-29.

*Eumorsea balli* Hebard, Trans. Amer. Entom. Soc., LXI, p. 121 (1935). (In part.) [Solely the Mount Graham, Pinaleno Mountains record.]

This species is at once separable from the closely related *E. balli* on the basis of the characters set forth in the preceding key. The closeness of its relationship to the genotypic species can only be determined after sufficient material becomes available to permit examination of the male's internal genitalia.

*Type.*— ♂, Mount Graham, Pinaleno Mountains, Graham Co., Arizona. August 21, 1934. (E. D. Ball.) [Academy of Natural Sciences of Philadelphia, Type no. 5813.]

Size large for the subfamily, but slightly smaller and more slender in form than *E. balli* (see measurements below). Apterous. Surface as in *E. balli.* Mid-dorsal length of head approximately equal to mid-dorsal pronotal length. Mid-longitudinal carina of vertex more strongly expressed than in *E. balli.* Fastigium, from above, laterally expanded, distally truncato-rounded, and produced before the eyes a distance equal to about one-half the narrowest interocular width (see fig. 26). Fastigio-facial angle acute, and in lateral aspect, well produced before the eyes; the fastigio-vertical area appreciably swollen in profile (see fig. 29). Face strongly retreating, its outline sinuate. Fastigium, in frontal aspect, exceeding the dorsal surfaces of the eyes by approximately one-half the least interocular width of the vertex, apically rounded and laterally expanded as seen in same aspect (see fig. 20). Frontal costa with the margins subparallel and constricted between and directly below the antennal insertions, diverging slightly below the median ocellus and tending to become obsolete in the same area, diverging dorsad of the antennal insertions and terminating before reaching apex of the fastigium (see fig. 20). Supplementary facial carinae strongly marked, subcarinate. Eyes protrusive, proportionately smaller and more elongate than in *E. balli.* Both antennae partly missing in type.

Pronotum rather elongate, about 1.25 times as long (dorso-longitudinally) as deep (dorsal surface of median carina to ventro-caudal border of lateral lobe). Median carina of pronotal disk rather strongly expressed, somewhat tectate. Lateral carinae of pronotal disk rounded, hardly expressed, but more evident than in *E. balli.* Pronotal lobes rather deep in relation to length, especially near caudal border.

All femora elongate, the caudal ones much more so than in *E. balli.* Cephalic femora about 9.1 times as long as wide; median femora about 6.7 times as long as wide; caudal femora about 8.4 times as long as wide. Caudal femur with apex unarmed (left caudal limb missing in type).

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[27] After the mountain range of which Mount Graham is the principal peak.

Margins of caudal tibiae armed with 20 well developed spines on external border and 18 similarly developed spines on internal border.

Apex of abdomen thickened. Supra-anal plate small, shield-shaped, about as broad basally as it is long. Cerci simple, surpassing tip of supra-anal plate, more elongate and slender than in *E. balli,* evenly tapering distad to the simple, rounded apex, appreciably curving toward the median line, cylindrical in section, but with the inner (mesal) surface flattened (see fig. 24). Subgenital plate similar in form to *E. balli,* the sides composed of triangulate sclerites with their apices fusing dorso-mesad, the medio-distal area less sclerotized and with a median carina in its upper two-thirds; dorsal border cingulate.

In color, the type is lighter than *E. balli,* but the pattern of coloration is approximately the same. The dorsum of the body bears a broad, mid-longitudinal stripe of buff to light tan extending from the fastigium to the eighth abdominal tergite. Laterally, a broad stripe of light brown to fuscous-brown (the latter color especially noticeable along the dorsal border of the stripe) occurs, extending from the genae to the ultimate abdominal tergites. Face, antennae and limbs buff to very light tan.

*Allotype.*—♀, Shake Trail at foot of Graham Mountains, Graham Co., Arizona. 9,000 feet. August 20, 1952. (H. B. Leech and J. W. Green.) [California Academy of Sciences.]

The following description is comparative with that of the male.

Size larger (see measurements below). Mid-dorsal length of head slightly less than mid-dorsal pronotal length (as 41:46). Fastigium, from above, produced before the eyes slightly less than one-half the narrowest interocular distance (as 7:16). In profile, the fastigio-vertical area is less appreciably swollen, the whole surface of the vertex being evenly convex in dorsal outline. Facial outline less sinuate, very weakly emarginate between the antennal insertions and the clypeus. Frontal costa with the rami less constricted interantennally, more divergent and irregularly parallel below the median ocellus. Antennae subclavate, subcompressed distad, ninth article bearing a minute tooth disto-ventrad. All but two basal articles of left antenna missing in allotype.

Pronotum with length subequal to depth. Pronotal disk definitely tectate. Lateral carinae of disk very sharply expressed, evenly diverging caudad to about middle of disk, thence rounding laterad and converging toward caudal border of disk. Lateral lobe of pronotum with ventral border weakly emarginate at about the middle, ventro-caudal border obtuse-angulate rounded.

Femora not as slender as in male sex. Cephalic femora about 6.3 times as long as deep; median femora about 5.9 times as long as deep; posterior femora about 7.4 times as long as deep. Caudal tibiae armed with 19 spines on external border and 17 along internal border.

Ovipositor similar to that found in *E. balli.* Dorsal valves minutely

serrulate on dorsal border, apically gently curving inward and upward. Ventral valves dentate along outer ventral border, bearing a single tooth near base on inner ventral border, apical tooth of ventral valves decurved. Subgenital plate with disto-lateral borders convex (as seen from below), medially produced in a spinose process which is much longer than in *E. balli* (see fig. 23).

Color much darker than type. Body almost entirely fuscous except for lighter brown areas along venter of thorax and abdomen. Face and genae grayish white, carinae along borders of anterior limbs marked with same color. Median and posterior limbs blotched with lighter brown. Lateral carinae of pronotal disk gray-brown.

Measurements (in millimeters) of type (given first) and allotype. Length of body, 11.7, 22.0; narrowest interocular width of vertex, .55, .85; greatest width of fastigium, .60, .95; greatest extent of fastigium cephalad of eyes, .25, .40; length of pronotum (mid-dorsal), 1.75, 2.40; greatest depth of pronotum (dorsal surface of median carina to ventro-caudal border), 1.25, 2.50; length of cephalic femur 4.4, 3.9; greatest depth of anterior femur, .48, .55; length of median femur, 3.8, 3.8; greatest depth of median femur, .56, .60; length of caudal femur, 9.5, 11.2; greatest depth of caudal femur, 1.1, 1.4.

A single additional specimen of this species, a very small male in an early instar is also before us. It was taken on Mount Graham, VIII-27-1937 by E. D. Ball and is deposited in the collections of the University of Arizona.

The species is known only from the three specimens recorded above.

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